ATTACHMENT H

CLOSURE/POST-CLOSURE PLAN
FOR THE TECHNICAL AREA 54
AREA L LANDFILL
(SHAFTS 1, 13-17, AND 19-34 AND IMPOUNDMENTS B AND D)

Closure/Post-Closure Plan for the Technical Area 54 Area L Landfill
(Shafts 1, 13-17, and 19-34 and Impoundments B and D)

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LIST OF ABBREVIATIONS/ACRONYMS

20.4.1 NMAC	New Mexico Administrative Code, Title 20, Chapter 4, Part 1
40 CFR	Code of Federal Regulations, Title 40
CMS	RCRA Corrective Measures Study
COC	contaminant(s) of concern
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration
ft	feet (foot)
FY	Fiscal Year
LANL	Los Alamos National Laboratory
MDA	material disposal area
NMED	New Mexico Environment Department
NMEID	New Mexico Environmental Improvement Division
OLASO	Office of Los Alamos Site Operations
R	regional aquifer
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
SWMU	solid waste management unit
SWRC	Solid Waste and Regulatory Compliance Group
TA	technical area
TCA	1,1,1-trichloroethane
VOC	volatile organic compound

CLOSURE/POST-CLOSURE PLAN FOR THE TECHNICAL AREA 54 AREA L LANDFILL (SHAFTS 1, 13-17, AND 19-34 AND IMPOUNDMENTS B AND D)

This closure/post-closure plan describes the activities necessary to achieve closure and post-closure of the Area L landfill at Los Alamos National Laboratory (LANL) Technical Area (TA) 54. The Area L landfill is an "active" unit comprised of Shafts 1, 13-17, and 19-34 and Impoundments B and D because they received hazardous waste after November 19, 1980. Hereinafter, the phrase "Area L landfill" is used to denote the active unit. The Area L landfill is also a "regulated unit," as defined in the New Mexico Administrative Code, Title 20, Chapter 4, Part 1 (20.4.1 NMAC) § 264.90(a)(2), revised June 14, 2000 [6-14-00]. The information provided in this plan is submitted to address the applicable closure and post-closure requirements specified in 20.4.1 NMAC § 270.14(b)(13); 20.4.1 NMAC, Subpart V, Part 264, Subparts F and G; and 20.4.1 NMAC § 264.310 [6-14-00].

The Area L landfill is located within the TA-54 Area L treatment and storage facility, which will continue to operate. The Area L landfill will be closed in place without removing the waste and is co-located with land disposal units that comprise solid waste management unit (SWMU) No. 54-006 managed under the LANL corrective action program. The closure and post-closure activities for the Area L landfill will be addressed through alternative requirements, as allowed by 20.4.1 NMAC § 264.110(c), to meet closure and post-closure care requirements. Alternative requirements are discussed further in Sections 1.3 and 3.2. Closure of the landfill will ensure that the existing asphalt cover and wastes and/or waste residues that remain in place are stabilized, as described in Section 2.0 of this plan. The cover will minimize the need for further maintenance and be protective of human health. Post-closure care will include monitoring, maintenance, and reporting, as described in Section 4.0 of this plan. These activities will occur in conjunction with and subject to the investigation and potential remediation efforts of the LANL corrective action program, as allowed by the alternative requirements process. Therefore, the final remedy for the Area L landfill will be part of the corrective measure for Area L as a whole when operations cease and will be implemented in accordance with the Corrective Action Chapter of this permit. An aid in demonstrating the proposed corrective action activities that will meet the applicable post-closure requirements for the regulated unit at Material Disposal Area (MDA) L is presented in Attachment A (MDA L: Operating Unit Regulations for Ground Water/Closure/Post-Closure Care and Corresponding HSWA Activities) of this plan.

A "Closure and Post-Closure Plan for TA-54 Area H and Area L Landfill at Los Alamos National Laboratory" was submitted to the New Mexico Environmental Improvement Division (NMEID, precursor to the New Mexico Environment Department [NMED]) in November 1986 (LANL, 1986). A "Closure Plan for Technical Area 54, Material Disposal Area L" was submitted in March 1998 (LANL, 1998a). This closure/post-closure plan is a revision to the previous plans.

This plan for the Area L landfill is organized as follows:

- General closure information (Section 1.0).
- Specific closure information (Section 2.0).
- General post-closure information (Section 3.0)
- Specific post-closure information (Section 4.0)

Until closure is complete and has been certified in accordance with 20.4.1 NMAC § 264.115 [6-14-00], as discussed in Section 1.7, a copy of the approved closure/post-closure plan and any approved revisions will be on file at LANL's Solid Waste and Regulatory Compliance Group (SWRC) and at the U.S. Department of Energy (DOE) Office of Los Alamos Site Operations (OLASO). Until final closure of the entire LANL facility, a copy of the approved plan will be furnished to the Secretary of the NMED, upon request, in accordance with 20.4.1 NMAC § 264.118(c) [6-14-00].

1.0 GENERAL CLOSURE INFORMATION

This section is prepared in accordance with the requirements of 20.4.1 NMAC § 270.14(b)(13); 20.4.1 NMAC, Subpart V, Part 264, Subparts G and H; and 20.4.1 NMAC § 264.310 [6-14-00], as applicable.

1.1 Partial and Final Closure Activities [20.4.1 NMAC § 264.112(d)]

Partial Resource Conservation and Recovery Act (RCRA) closure is the closure of a hazardous waste management unit at a facility that contains other active hazardous waste management units. This partial closure will consist of closing the Area L landfill, while leaving the other units at LANL in operation. Partial closure (hereinafter referred to as closure) will be deemed complete when closure in place has been verified, alternative requirements to meet post-closure care requirements have been implemented, the closure certification has been submitted to the NMED, and the NMED has approved the closure.

As described in the proposed General Closure Plan submitted to the NMED in November 2001, final RCRA closure of the entire LANL hazardous waste management facility will occur when all of LANL's hazardous/mixed waste management units are closed. Final closure will consist of assembling documentation on the closure status of each unit, including all previous partial clean closures as well as land-based units that have been or are being addressed via alternative closure requirements. Final closure will be deemed complete when the closure certification has been submitted to the NMED and the NMED has approved the final closure.

1.2 Closure Performance Standard [20.4.1 NMAC § 264.111]

The Area L landfill (Shafts 1, 13-17, and 19-34 and Impoundments B and D) will be closed to meet the following performance standards:

- Minimize the need for further maintenance
- Control, minimize, or eliminate, to the extent necessary to protect human health and the environment, the post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated runoff, or hazardous waste decomposition products to the ground or surface waters or atmosphere
- Comply with the applicable closure and post-closure requirements of 20.4.1 NMAC, Subpart V, Part 264, Subpart G and 20.4.1 NMAC § 264.310 [6-14-00].

To meet the above closure performance standards and the closure requirements in 20.4.1 NMAC § 264.310(a), the existing covers on the specified shafts and impoundments that comprise the Area L landfill have been designed and constructed to:

- Minimize migration of liquids through the closed unit
- Function with minimum maintenance
- Promote drainage and minimize erosion or abrasion of the cover
- Accommodate settling and subsidence so that the cover's integrity is maintained, and
- Have a permeability that is less than or equal to the permeability of the natural subsoils present.

1.3 Closure Activities and Alternative Requirements

Closure activities for the Area L landfill will be addressed under alternative requirements, pursuant to 20.4.1 NMAC § 264.118(b)(4). This allowable option is defined in 20.4.1 NMAC § 264.110(c) when a regulated unit is located among other SWMUs, releases potentially originating from both the regulated unit and the SWMU(s) have or are likely to have occurred, and the alternative requirements will meet the closure performance standards set forth in 20.4.1 NMAC § 264.111. At

Area L, the impoundments and shafts identified as the regulated unit are in close proximity to (i.e., co-located with) similar disposal units (included in SWMU No. 54-006) to be addressed under the LANL corrective action program. A subsurface volatile organic compound (VOC) vapor-phase plume was detected in the vadose zone and has been monitored at MDA L since the mid-1980s. U. S. Environmental Protection Agency (EPA) guidance for the rule (EPA, 1998) discusses the transfer of the closure and post-closure process to the facility corrective action process (contained in the Corrective Action Chapter of this permit) as an appropriate mechanism to address this situation.

Closure of the Area L landfill will ensure that the existing cover and wastes and/or waste residues that remain in place are stabilized, as described in Section 2.0. The cover will minimize the need for further maintenance and be protective of human health.

1.4 Closure Schedule [20.4.1 NMAC § 264.112(b)(6)]

Written closure plans are required for owners and operators of a hazardous waste management facility, pursuant to 20.4.1 NMAC § 264.112(a)(1). In addition, the plan must be submitted with the permit application and approved by the Secretary of the NMED as part of the permit issuance procedures under the Code of Federal Regulations, Title 40 (40 CFR), Part 124.

In accordance with 20.4.1 NMAC § 264.112(d)(1), written notification must be provided to the Secretary of the NMED at least 60 days prior to the date on which final closure of the landfill is expected to begin. Closure will be conducted in accordance with the schedule presented in Table 1. In the event that the closure of the Area L landfill is prevented from proceeding according to schedule, LANL will notify the Secretary of the NMED in accordance with extension request requirements in 20.4.1 NMAC § 264.113(b) [6-14-00].

1.5 Amendment of the Closure Plan [20.4.1 NMAC § 264.112(c)]

In accordance with 20.4.1 NMAC § 264.112(c) [6-14-00], LANL will submit a written notification of or request for a permit modification to authorize a change in the approved closure plan whenever:

- There are changes in operating plans or facility design that affect the closure plan
- There is a change in the expected year of closure
- Unexpected events occur during closure that require modification of the approved closure plan
- The owner or operator requests the Secretary of the NMED to apply alternative requirements to a regulated unit under 20.4.1 NMAC §§ 264.90(f) and/or 264.110(c).

The written notification or request will include a copy of the amended closure plan for approval by the NMED.

LANL will submit a written request for a permit modification with a copy of the amended closure plan at least 60 days prior to the proposed change in unit design or operation or no later than 60 days after an occurrence of an unexpected event that affects the closure plan. If the unexpected event occurs during closure, the permit modification will be requested within 30 days of the occurrence. The Secretary of the NMED may request a modification of the closure plan under the conditions presented in the bulleted items above. LANL will submit the modified plan in accordance with the request within 60 days of notification, or within 30 days of notification if a change in facility condition occurs during the closure process.

1.6 Closure Cost Estimate, Financial Assurance, and Liability Requirements [20.4.1 NMAC § 264.140(c)]

In accordance with 20.4.1 NMAC § 264.140(c) [6-14-00], LANL, as a federal facility, is exempt from the requirements of 20.4.1 NMAC, Subpart V, Part 264, Subpart H [6-14-00] to provide a cost estimate, financial assurance mechanism, and liability insurance for closure actions.

1.7 Closure Certification [20.4.1 NMAC § 264.115]

Within 60 days after completion of closure activities for the Area L landfill, LANL will submit to the Secretary of the NMED, via certified mail, a certification that the unit has been closed in accordance with the approved closure plan. The certification will be signed by the appropriate DOE and LANL officials and by an independent, registered professional engineer, in accordance with 20.4.1 NMAC § 264.115 [6-14-00]. Documentation supporting the independent, registered engineer's certification will be furnished to the Secretary of the NMED upon request, as specified in 20.4.1 NMAC § 264.115 [6-14-00]. A copy of the certification and supporting documentation will be maintained by both the DOE/OLASO and the SWRC Group.

1.8 Security

Because of the ongoing nature of waste management operations at TA-54, security and administrative controls for the Area L landfill will be maintained by the DOE or another authorized federal agency for as long as necessary to prohibit public access. The security fence at TA-54 will be maintained to ensure that public access into Area L is prevented.

1.9 Closure Report

Upon completion of the closure activities at the Area L landfill, a closure report will be prepared and, upon request, provided to the Secretary of the NMED. The report will document the closure and contain, for example, the following:

- A copy of the certification described in Section 1.7 of this plan
- A general summary of closure activities
- Any significant variance from the approved activities and the reason for the variance
- A summary of any sampling data associated with closure
- The location of the file of supporting documentation (e.g., memos, logbooks, laboratory sample analysis data)
- Storage or disposal location of hazardous/mixed waste resulting from closure activities
- A certification of accuracy of the report.

1.10 Survey Plat [20.4.1 NMAC § 264.116]

LANL intends to meet closure/post-closure requirements by implementing alternative requirements allowable under 20.4.1 NMAC § 264.110(c): leaving waste in place; ensuring waste/waste residues are stabilized; and performing the activities described in Sections 3.0 and 4.0. A survey plat prepared in accordance with 20.4.1 NMAC § 264.116 [6-14-00] will be filed with the appropriate authorities at certification of closure, as described in that regulation. A survey plat indicating the location and dimensions of Shafts 1, 13-17, and 19-34 and Impoundments B and D at MDA L with respect to permanently surveyed benchmarks will be submitted to the local zoning authority (i.e., Los Alamos County) and to the NMED at the time of submission of the certification of closure. The plat will be prepared and certified by a professional land surveyor. The plat filed with the local zoning authority will contain a prominently displayed note, which states the obligation of LANL and DOE to restrict disturbance of the unit in accordance with the applicable regulations in 20.4.1 NMAC, Subpart V, Part 264, Subpart G.

2.0 SPECIFIC CLOSURE INFORMATION

This section provides a general description of TA-54, Area L, and MDA L. It also presents a more detailed description of the Area L regulated unit, as defined in 20.4.1 NMAC § 264.90(a)(2), and includes a discussion of the wastes in and the maximum capacities of the specified shafts and impoundments. In addition, specific closure information for the shafts and impoundments is presented herein. LANL does not currently intend to reduce the areal extent nor the design capacities of the treatment and storage units at Area L during the active life of those units. The most recent estimated annual quantities for the waste treatment and storage units at Area L are provided in the “Los Alamos National Laboratory General Part A Permit Application,” Revision 0.0/0.1/1.0/2.0 (LANL, 2001). A description of the geology, hydrology, and groundwater characterization at TA-54, Area L, is presented in Attachment B of this plan. Attachment C of this plan presents information on the nature and extent of releases at MDA L, as well as a brief assessment of present-day risk.

2.1 TA-54 Description

TA-54 is located on top of Mesita del Buey, an east-west trending mesa that is bordered on the north by Cañada del Buey and on the south by Pajarito Canyon. The elevation at TA-54 is approximately 6,800 feet (ft). TA-54 is used primarily for waste management. It includes four MDAs (one each at Areas G, H, J, and L) (Figure 1), hazardous/mixed waste storage and treatment areas, and numerous supporting offices. The Radioassay and Nondestructive Testing Facility is located in the western part of TA-54 (TA-54 West).

2.2 Area L and MDA L Description

Area L is a 2.58-acre site in the north-central portion of TA-54 (Figure 2). The irregularly-shaped area, located on the north side of Mesita del Buey Road, is surrounded by an 8-ft-high chain-link security fence with barbed wire or razor wire at the top. The fence is inspected weekly and repairs made, if necessary. Area L is kept locked at all times, with entrance to the area restricted to authorized and/or escorted personnel. Historically, MDA L was used for disposal of chemical wastes in 34 shafts, 3 impoundments, and 1 pit. MDA L is designated as SWMU No. 54-006. Disposal no longer occurs at MDA L. The surface of Area L is presently used for hazardous waste storage and treatment, and for mixed waste storage.

Near Area L, Cañada del Buey is roughly 100 ft below the north mesa rim, and Pajarito Canyon is approximately 140 ft below the south mesa rim. Runoff at Area L is primarily from sheet flow, which is channeled northward into a drainage that is a tributary of Cañada del Buey. Erosion controls at Area L divert water away from MDA L; these include an asphalt cover, asphalt curbing, and asphalt drainage channels.

The following are descriptions of the subsurface shafts, impoundments, and pit at MDA L. The descriptions were taken from the “RFI Work Plan for Operable Unit 1148" (LANL, 1992a) and the “Closure Report: Technical Area 54 Waste Oil Storage Tanks” (LANL, 1992b).

Between 1975 and 1985, 34 chemical waste disposal shafts at Area L were dry-drilled with an auger into the Bandelier Tuff. The shafts, located at the east and west ends of Area L, have all been capped with concrete and are no longer in use. Backfill was added around some of the shafts, where necessary, and the surface covered with asphalt. Only Shafts 1, 13-17, and 19-34 (Figure 2) received hazardous waste after November 19, 1980, making them subject to regulation under RCRA as active disposal shafts. Therefore, these shafts are subject to RCRA closure standards and are addressed in this plan.

Three unlined impoundments once used for waste treatment and disposal are located at MDA L. These impoundments are located in the north-central region of Area L and are designated from east to west as Impoundments B, C, and D (Figure 2). Only Impoundments B and D received hazardous waste after November 19, 1980. Hence, they are subject to RCRA closure standards and are addressed in this plan. Upon concurrence in 1988 with the NMEID, the impoundments were backfilled and the ground surface was covered with asphalt. Until RCRA closure is complete, these impoundments are considered active. Impoundment C became inactive prior to November 19, 1980, and is therefore subject to the Corrective Action Chapter of LANL's renewed Hazardous Waste Facility Permit, but not closure standards. Impoundment C is currently included in an investigation of Area L by LANL's Environmental Restoration (ER) Project. A container storage dome (TA-54-215) was placed over a portion of the asphalt pad above the impoundments in 1995.

In previous documents, Impoundment C was described as a unit that received hazardous waste after November 19, 1980. Upon further investigation of LANL records, this has been determined to be incorrect. Logbooks of waste management activities indicate that Impoundment C was closed in July 1978. The impoundment is included in SWMU No. 54-006 and is subject to corrective action. Therefore, it is not addressed in this plan.

Pit A is located in the eastern portion of Area L. This unlined disposal pit was used from 1964 to 1978. Pit A became inactive prior to November 19, 1980, and is therefore subject to the Corrective Action Chapter of LANL's renewed Hazardous Waste Facility permit, but not closure standards. It is currently included in an investigation of Area L by LANL's ER Project.

2.2.1 Shafts 1, 13-17, and 19-34

Shafts 1, 13-17, and 19-28 are located at the eastern end of Area L; Shafts 29-34 are located at the northwest end (Figure 2). The dates of use, dimensions, capacities, and waste contents of these shafts are presented in Table 2. Three feet of crushed tuff was placed in the bottom of each shaft to fill cracks and joints in the tuff. When in use, the shafts were covered with a heavy steel cap to prevent inflow of precipitation. The steel cap could be opened or removed, depending on the design, to allow emplacement of waste.

Prior to 1982, liquids were disposed of in drums or other containers without adding sorbents; containers were sometimes dropped into a shaft (LANL, 1992a). Noncontainerized waste was also disposed of in these shafts. After 1981, no noncontainerized wastes were disposed of in the shafts. From November 1982 until February 1985, wastes were accumulated on site and packaged in drums until sufficient quantities had amassed to facilitate subsequent emplacement. The drums were lowered by crane into a shaft through doors in the steel cap and arranged in layers. Layers in 3-ft and 4-ft diameter shafts contain 1 drum, layers in 6-ft diameter shafts contain 4 to 5 drums, and layers in 8-ft diameter shafts contain 6 drums. The space around the drums was filled with crushed tuff, and a 6-inch layer of crushed tuff was placed between each layer of drums. The crushed tuff provides structural support to help prevent failure of drums in the bottom of the shafts (LANL, 1992a). When the use period for these disposal shafts ended, they were backfilled with crushed tuff and approximately the uppermost 3 ft of each shaft was plugged with concrete, which was rounded at the surface to form a dome (LANL, 1986).

2.2.2 Impoundments B and D

Impoundment B was excavated in 1978. It is approximately 60 ft long, 18 ft wide, and 10 ft deep. Impoundment B was used from January 1979 through June 1985. This 7,560-cubic-ft capacity impoundment was used to evaporate batch-treated salt solutions (e.g., ammonium bifluoride) and electroplating wastes (e.g., chromium wastes). The impoundment capacity was calculated assuming it was to be filled to within 3 ft of the surface. The treated aqueous waste was discharged into the impoundment, where it pooled and was left to evaporate. Impoundment B was backfilled with clean fill and later covered with asphalt.

Impoundment D was used to treat small batch quantities of lithium hydride by reacting it with water. The neutralized liquid from this treatment was then allowed to evaporate. This practice, which began in 1972, was discontinued in 1984 for safety reasons. The approximately 75-ft-long, 18-ft-wide, 10-ft-deep impoundment was not used for disposal of any other hazardous wastes. Air photos indicate that Impoundment D was backfilled with clean fill and covered with asphalt in the late 1980s (LANL, 1992a).

After treatment of lithium hydride was discontinued, a rectangular 5,650-gallon steel waste-oil storage tank was placed in the 9,450-cubic-ft capacity impoundment (LANL, 1992a). The impoundment capacity was calculated assuming it was to be filled to within 3 ft of the surface. A 5,086-gallon waste-oil tanker truck was parked at the surface adjacent to and just west of Impoundment D, and four 771-gallon fiberglass waste-oil storage tanks were stored at the surface adjacent to and just east of the impoundment. When the six waste-oil storage tanks were closed, it was decided that closure would not include removal of any associated contaminated soil; rather, the soil would be addressed during closure and corrective actions at Area L. Prior to backfilling the area with clean fill, a plastic liner was placed on the ground and in the open impoundment (LANL, 1992b). Closure of the tanks was completed by removal in 1990, and a closure report was submitted to the NMED in 1992 (LANL, 1992b).

2.3 Closure Procedures

The Area L landfill (Shafts 1, 13-17, and 19-34 and Impoundments B and D) is capped by the existing asphalt cover and the vadose zone is monitored. The wastes and/or waste residues in these specified shafts and impoundments will be closed in place as a landfill. No wastes will be removed at the end of active operations.

2.3.1 Shafts 1, 13-17, and 19-34 Closure Procedures

Historically, when a shaft was filled or when it was determined that a shaft would no longer be used for disposal, it was backfilled with crushed tuff. Concrete was used to plug approximately the uppermost 3 ft of each shaft. The surface of this plug was capped with a concrete dome, which extends approximately 1 ft beyond the shaft circumference. The height of each concrete cap above the surface ranged from 8 to 12 inches. Brass markers were placed in the centers of the domed concrete caps to identify individual shafts. The backfill in the shafts helps to stabilize the wastes in the shafts and accommodate settling and subsidence so that the cap's integrity is maintained, and the existing asphalt (described below) helps to minimize infiltration of precipitation to the closed shafts. The existing asphalt cover over the Area L landfill will be inspected and repaired (as necessary), as described in Section 4.2.1.

At the east end of Area L and near the south fence, between 4 and 8 inches of soil was used to backfill the area around the shafts to bring the surface level to near the top of the shafts. This resulted in a benched area, over which a nominal 4-inch-thick layer of asphalt was then laid down. Asphalt also covers the sloped area between the benches, as well as the surrounding areas. The asphalt at the eastern end of Area L slopes to the northeast, providing a gradient for surface water runoff to the area's single discharge point through a flume that discharges into a tributary of Cañada del Buey. At the western end of Area L and along the north fence, up to 1.5 ft of soil was used to backfill the area and provide a gently sloping surface. A nominal 4-inch-thick layer of asphalt was then laid down over the backfill and the surrounding areas. Asphalt also covers the sloped areas at the edge of the backfill. The asphalt at the western end of Area L slopes gently to the north, and an asphalt swale surrounding the north side of the backfilled area channels precipitation toward the area's discharge point. The gently sloping asphalt, which also covers the surrounding areas, will help to minimize infiltration of precipitation, as well as function with minimum maintenance, promote drainage and minimize erosion or abrasion of the cover, and have a permeability less than that of the natural subsoils present, in accordance with 20.4.1 NMAC § 264.310(a). In addition, the asphalt provides run-on and runoff control, pursuant to 20.4.1 NMAC § 264.112(b)(5).

2.3.2 Impoundments B and D Closure Procedures

When it was determined that an impoundment would no longer be used for treatment or disposal, it was backfilled with clean fill and later covered with asphalt. Prior to placement of Storage Dome 215, this asphalt layer was broken up and left in place as a base coarse, upon which approximately four ft of clean fill was placed and compacted in lifts and graded. The new clean fill was then covered with an approximate 3-inch-thick asphalt pad. The original backfill helps to stabilize the waste residues in the impoundments, and the subsequent backfill helps to accommodate settling and subsidence so that the asphalt cover's integrity is maintained. The existing asphalt (further described below) helps to minimize infiltration of precipitation to the closed impoundments. The existing asphalt cover over the Area L landfill will be inspected and repaired (as necessary), as described in Section 4.2.1.

The asphalt cover slopes gently to the northeast and channels surface runoff to the area's discharge point. The gently sloping asphalt, which also covers the surrounding areas, will also help to minimize infiltration of precipitation, as well as function with minimum maintenance, promote drainage and minimize erosion or abrasion of the cover, and have a permeability less than that of the natural subsoils present, in accordance with 20.4.1 NMAC § 264.310(a). In addition, the asphalt provides run-on and runoff control, pursuant to 20.4.1 NMAC § 264.112(b)(5).

3.0 GENERAL POST-CLOSURE INFORMATION

This section is prepared in accordance with the requirements of 20.4.1 NMAC § 270.14(b)(13); 20.4.1 NMAC, Subpart V, Part 264, Subparts G and H; and 20.4.1 NMAC § 264.310 [6-14-00], as applicable.

3.1 Closure Performance Standard

Post-closure of the Area L landfill (Shafts 1, 13-17, and 19-34 and Impoundments B and D) will meet the following performance standards:

- Minimize the need for further maintenance
- Control, minimize, or eliminate, to the extent necessary to protect human health and the environment, the post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated runoff, or hazardous waste decomposition products to the ground or surface waters or atmosphere
- Comply with the applicable closure and post-closure requirements of 20.4.1 NMAC, Subpart V, Part 264, Subparts G and N [6-14-00].

After closure, the measures by which LANL will meet the applicable 20.4.1 NMAC § 264.310(b) requirements (or equivalents thereof) are presented in Sections 4.1 and 4.2 of this plan. Post-closure of the landfill will be accomplished under alternative closure requirements, as allowed by 20.4.1 NMAC § 264.110(c) and as discussed in Section 3.2 below, to meet post-closure care requirements.

3.2 Post-Closure Care and Alternative Requirements

In accordance with 20.4.1 NMAC §264.117(a)(1), post-closure care for the Area L landfill will begin after completion of closure of the unit and will continue for 30 years. Post-closure care of the regulated unit under alternative requirements will begin after closure is complete, as described in Section 2.3 of this plan, and closure is certified by LANL and approved by the NMED. The Secretary of the NMED may shorten the post-closure care period at any time preceding partial closure or during the post-closure period if all disposal units at the facility are closed and it is determined that the reduced period is sufficient to protect human health and the environment, in accordance with 20.4.1 NMAC § 264.117(a)(2)(i). Alternatively, the Secretary of the NMED may extend the post-closure care period if it is determined that the extended period is necessary to protect human health and the environment, in accordance with 20.4.1 NMAC § 264.117(a)(2)(ii).

Post-closure activities for the Area L landfill will be addressed under alternative requirements, as allowed by 20.4.1 NMAC § 264.118(b)(4). This allowable option is defined in 20.4.1 NMAC §

264.110(c) when a regulated unit is located among SWMUs, releases potentially originating from both the regulated unit and the SWMU(s) have or are likely to have occurred, and the alternative requirements will meet the closure performance standards set forth in 20.4.1 NMAC § 264.111. At the Area L landfill, the impoundments and shafts identified as the regulated unit are in close proximity to (i.e., co-located with) similar disposal units (SWMU No. 54-006) to be addressed under the LANL corrective action program. A subsurface VOC vapor-phase plume was detected in the vadose zone and has been monitored at MDA L since the mid-1980s. EPA guidance for the rule (EPA, 1998) discusses the transfer of the post-closure process to the facility corrective action process (contained in the Corrective Action Chapter of this permit) as an appropriate mechanism to address this situation. Therefore, some post-closure procedures for the Area L regulated unit will be established as part of the corrective measures to be identified for the ongoing corrective action program at TA-54.

As required by 20.4.1 NMAC § 264.117(a)(1)(i and ii), post-closure care of the Area L landfill will include maintenance, monitoring, and reporting as appropriate and in accordance with the requirements of 20.4.1 NMAC, Subpart V, Part 264, Subpart F and 20.4.1 NMAC § 264.310, as described in Section 4.0. As described in Section 2.3 of this plan, the landfill is covered by the existing asphalt. The integrity and effectiveness of the cover will be maintained, including conducting inspections and making necessary repairs to correct the effects of settling, erosion, water damage, or other events.

A RCRA Facility Investigation (RFI) is currently ongoing at MDA L. NMED will determine whether a RCRA Corrective Measures Study (CMS) is required, based on the findings of the RFI. Vadose zone monitoring of the Area L landfill will be performed in accordance with the findings of the RFI regarding the current monitoring system. Groundwater monitoring will be developed for TA-54 as an aggregate under the LANL "Hydrogeologic Workplan" (LANL, 1998b) and implemented as appropriate by LANL's Groundwater Protection Program, as described in Section 4.1.2.

If further corrective measures at the Area L landfill are deemed necessary to protect human health and the environment, they will be analyzed, selected, and implemented during the CMS process according to the requirements of the Corrective Action Chapter of LANL's renewed Hazardous Waste Facility Permit and the most current and approved Installation Work Plan for the ER Project. The selected corrective measure will include alternative requirements for post-closure of the Area L landfill in a manner that complies with the requirements of 20.4.1 NMAC § 264.110(c)(2), and the selection and implementation must be approved by the NMED as a permit modification.

An aid in demonstrating the proposed corrective action activities that will meet the applicable post-closure requirements for the regulated unit at MDA L is presented in Attachment A of this plan.

3.3 Amendment of the Post-Closure Plan

In accordance with 20.4.1 NMAC § 264.118(d)(1) [6-14-00], LANL may submit a written notification of or request for a permit modification to authorize a change in the approved post-closure plan at any time during the active life of the facility or during the post-closure care period. In accordance with 20.4.1 NMAC § 264.118(d)(2) [6-14-00], LANL will submit a written notification of or request for a permit modification to authorize a change in the approved post-closure plan whenever:

- There are changes in operating plans or facility design that affect the approved post-closure plan
- There is a change in the expected year of final closure, if applicable
- Events which occur during the active life of the facility, including partial and final closures, affect the approved post-closure plan
- LANL requests the Secretary of the NMED to apply alternative requirements (e.g., if corrective action necessitates changes to the closure configuration or the post-closure care requirements) to a regulated unit under 20.4.1 NMAC § 264.90(f) and/or §264.110(c).

The written notification or request will include a copy of the amended post-closure plan for review or approval by the NMED, in accordance with 20.4.1 NMAC § 264.118(d).

LANL will submit a written request for a permit modification at least 60 days prior to the proposed change in unit design or operation, or no later than 60 days after an occurrence of an unexpected event that affects the post-closure plan. The Secretary of the NMED will approve, disapprove, or modify this plan in accordance with the procedures in 40 CFR, Part 124 and 20.4.1 NMAC, Subpart IX, Part 270. The approved post-closure plan will become a permit condition, in accordance with 20.4.1 NMAC § 270.32.

The Secretary of the NMED may request modifications to the plan under the conditions presented in the bulleted items above. LANL will submit the modified plan no later than 60 days after the Secretary's request. Any modifications requested by the Secretary will be approved, disapproved, or modified in accordance with the procedures in 40 CFR, Part 124 and 20.4.1 NMAC, Subpart IX, Part 270.

In accordance with 20.4.1 NMAC § 264.119(c), LANL or a subsequent owner or operator may request a modification to the approved post-closure plan to authorize the removal of hazardous wastes and hazardous waste residues or contaminated soils. If a permit modification to conduct such removal activities is granted, the owner or operator may request that the Secretary of the NMED approve the removal of the post-closure notice filed with the County of Los Alamos, other authorized agencies, or the Secretary of the NMED. Alternatively, the owner or operator may provide an additional post-closure notice indicating the removal of the hazardous waste, with approval from the Secretary of the NMED.

3.4 Post-Closure Cost Estimate, Financial Assurance, and Liability Requirements [20.4.1 NMAC § 264.140(c)]

In accordance with 20.4.1 NMAC § 264.140(c) [6-14-00], LANL, as a federal facility, is exempt from the requirements of 20.4.1 NMAC, Subpart V, Part 264, Subpart H [6-14-00] to provide a cost estimate, financial assurance mechanisms, and liability insurance for post-closure actions.

3.5 Post-Closure Certification [20.4.1 NMAC § 264.120

Within 60 days after completion of the established post-closure care period for the Area L landfill, LANL will submit to the Secretary of the NMED, by registered mail, a certification that the post-closure care period for the unit was performed in accordance with the approved post-closure plan. The certification will be signed by the appropriate DOE and LANL officials and by an independent, registered professional engineer. Documentation supporting the independent, registered professional engineer's certification will be furnished to the Secretary of the NMED upon request. A copy of the certification and supporting documentation will be maintained by DOE/OLASO. The supporting documentation may include, for example, the following:

- Any significant variance from the approved activities and the reason for the variance
- A summary of all sampling results
- A quality assurance/quality control statement on analytical data validation
- The location of the file of supporting documentation
- Storage or disposal location of hazardous/mixed waste resulting from post-closure activities.

3.6 Security

Because of the ongoing nature of waste management operations at TA-54, security and administrative controls for the Area L landfill will be under the care of the DOE or another authorized federal agency during the post-closure care period. The security fence at TA-54 will be maintained during that period to prohibit public access into Area L.

3.7 Survey Plat and Post-Closure Requirements [20.4.1 NMAC § 264.116 and § 264.117 through § 264.120]

As stated in Section 1.10, a survey plat prepared in accordance with 20.4.1 NMAC § 264.116 [6-14-00] will be filed with the appropriate authorities at certification of closure. No later than 60 days after certification of closure of the Area L landfill, LANL will submit to the County of Los Alamos and other authorized agencies and to the Secretary of the NMED a record of the type, location, and quantity of hazardous wastes disposed of within the unit. For hazardous wastes disposed of before January 12, 1981, LANL will identify the type, location, and quantity of the hazardous wastes to the best of their knowledge and in accordance with any records that have been kept.

Post-closure care pursuant to 20.4.1 NMAC § 264.117 through § 264.120 [6-14-00] will begin after closure of a disposal unit. Post-closure notices will be filed with appropriate authorities within 60 days of certification of closure of the first disposal unit and within 60 days of certification of closure of the last disposal unit, as described in 20.4.1 NMAC § 264.119 [6-14-00]. To meet that requirement, DOE will file a "Land Use Restriction Notice" or equivalent document with the County of Los Alamos and other authorized agencies. The "Land Use Restriction Notice" will indicate that the land has been used to manage hazardous wastes and that its use is restricted under 20.4.1 NMAC, Subpart V, Part 264, Subpart G regulations. It will also indicate that the survey plat and record of the type, location, and quantity of hazardous wastes disposed of have been filed with the County of Los Alamos and other authorized agencies and with the Secretary of the NMED. LANL will also submit a certification, signed by DOE and LANL, that they have recorded the notation specified in 20.4.1 NMAC § 264.119(b)(1), including a copy of the document in which the notation has been placed, to the Secretary of the NMED.

Within 60 days after completion of the established post-closure care period for the unit, LANL will submit to the Secretary of the NMED, via certified mail, a certification of completion of post-closure care in accordance with the requirements of 20.4.1 NMAC § 264.120 [6-14-00]. Certification of completion of post-closure care is described in Section 3.5.

4.0 SPECIFIC POST-CLOSURE INFORMATION

Pursuant to 20.4.1 NMAC § 264.118(b), the post-closure portion of this plan identifies the activities that will be conducted after closure of the Area L landfill and the frequency of these activities. Post-closure activities for the Area L landfill will be addressed under alternative requirements, pursuant to 20.4.1 NMAC § 264.118(b)(4). These post-closure activities are described below in Sections 4.1 and 4.2, and include activities that are planned as well as those that may be conducted as a result of the corrective action process.

This section describes these activities, which include monitoring activities and the frequencies at which they will be performed to be consistent with 20.4.1 NMAC, Subpart V, Part 264, Subpart F, as appropriate, and 20.4.1 NMAC § 264.310 during the post-closure care period, in accordance with 20.4.1 NMAC § 264.118(b)(1). The activities also include maintenance activities and the frequencies at which they will be performed, as required in 20.4.1 NMAC § 264.118(b)(2).

4.1 Monitoring and Frequency

The monitoring activities and the frequencies at which they will be performed, pursuant to 20.4.1 NMAC § 264.118(b)(1), are described to the extent known in the following sections. Monitoring of the vadose zone and groundwater will be conducted as appropriate according to currently existing schedules, pending potential modifications as determined by the RFI/CMS process and/or implementation of LANL's Groundwater Protection Program. The frequency of monitoring for each medium is also discussed.

4.1.1 Vadose Zone

Vadose zone monitoring at MDA L has been ongoing since the mid-1980s. As reported in Appendix C of the "Quarterly Technical Report July-September 2001" (ER Project, 2001), the VOC vapor-phase plume (as represented by 1,1,1-trichloroethane [TCA] screening data) has been measured to be near a steady condition since the first quarter of Fiscal Year (FY) 99. As indicated by the screening results, the 10-parts per million by volume contour remained relatively constant at depth, approximately 650 ft above the regional groundwater table. The report also indicated that the maximum TCA concentrations have been measured to remain relatively steady since FY 99.

As concluded in the "Subsurface Vapor-Phase Transport of TCA at MDA L: Model Predictions" (Stauffer et al., 2000), the observed site data and site numerical modeling results also indicate that, currently, the vapor-phase plume at MDA L is at a near steady condition, both in concentration and size. The authors also concluded that the current location of the vapor-phase plume is not expected to spread any closer to White Rock or to the deep aquifer. In addition, because there is no evidence of liquid migration and it has been determined that saturated flow through the tuff is not a viable transport mechanism, it is not anticipated that VOCs can migrate as liquids to the uppermost aquifer (Stauffer et al., 2000; IT Corporation, 1987). It is predicted that the plume size will begin to decrease when the contaminant source is depleted (likely before the year 2060), based on estimates of a conservative TCA source. The site numerical model will provide a useful tool in the future to explore the effects of potential corrective measures (e.g., passive venting, optimized passive venting) (Stauffer et al., 2000).

The pore-gas monitoring program has been successful in defining both the nature and extent of the vapor-phase plume at MDA L, as indicated by the agreement of the numerical model with pore-gas and surface flux data. Both the current and future plume growth over the next 50 years are anticipated to be quite small, according to the simulations (e.g., by the year 2050, the simulation results for the 50 parts per million by volume TCA contour show very little lateral growth) (Stauffer et al., 2000). The modeling results indicate that pore-gas monitoring could be performed less frequently than the current quarterly regime, and less frequent monitoring is supported by the recent observations of slowly changing pore-gas concentrations. It is believed that annual monitoring would be sufficient to identify any significant changes in the plume, as demonstrated by the simulation of catastrophic drum failure that predicts that such an event would be captured in the monitoring data for several years. Overall, annual monitoring is believed to be capable of assessing the current rate of plume growth as well as detecting a large perturbation to the system (e.g., a drum failure) (Stauffer et al., 2000).

Although the actual frequency of monitoring is not precisely known at this time, the "RFI Report for Material Disposal Area L at Technical Area 54", which will be submitted to the NMED in 2002, may recommend semi-annual pore-gas monitoring for a 2-year period, followed thereafter with annual pore-gas monitoring. Monitoring and monitoring frequency of the vadose zone will also be addressed under the remaining portions of the corrective action process (e.g., CMS, Corrective Measures Implementation).

4.1.2 Regional Aquifer Groundwater

Five regional aquifer (R) wells are planned for installation in the vicinity of TA-54. These wells include R-16, R-20, R-21, R-22, and R-23. The five wells are included in or associated with Aggregate 2, the boundaries of which were drawn to encompass the SWMUs at TA-54. Well R-22 was installed in the fall of 2000. Currently, well R-21 is planned for completion in FY 02. The remaining wells (R-16, R-20, and R-23) are also planned for completion in FY 02, contingent upon the approval of additional funding requested in April 2002.

The groundwater analytical strategy being implemented at LANL is described herein. The first step in the strategy is installation of a characterization well, followed by collection of water samples from each well screen upon well completion. For single-completion wells, there is no activity for a 3-month period after borehole sampling while the well equilibrates. For multiple-completion wells, no activity occurs for a 6-month period after borehole sampling while the well equilibrates. The second step is collection of initial characterization samples (i.e., the first sampling round) from each well screen and analysis for a full suite of analytes, provided the yield at any screened interval is a sufficient volume for a full analytical suite. Otherwise, the analyses will be prioritized according to suspected contaminants of concern (COC). For each well screen, if compounds and/or radionuclides are not detected in the first sampling round, they will be deleted from the analyte list for the second and third sampling rounds unless the compound or radionuclide is a COC. If compounds and/or radionuclides are detected in the first sampling round, the appropriate well screens will be selected for subsequent sampling based on data needs; the plans for subsequent sampling and analysis will be discussed with the NMED. The third step is conducting the second and third sampling and analysis rounds. The final step is collection of the fourth round of samples from each well screen and analysis for a full suite of analytes.

Upon completion of four sampling rounds at each well installed pursuant to the "Hydrogeologic Workplan" (LANL, 1998b), the well will be incorporated into LANL's Groundwater Protection Program. These wells will be used to enhance the program by serving as monitoring wells and/or providing information to determine potential future locations for additional monitoring wells. The well data will be entered into the well inventory module of the Water Quality Database. This database will be available to LANL and external stakeholders. Data customers (e.g., regulators, LANL personnel, or other stakeholders) can then examine the information and, if appropriate and necessary, request samples, measurements, or other data to be collected from any well. Under the Groundwater Protection Program, all water sampling, water-level measurements, and other testing will be implemented consistent with laws, regulations, and DOE orders, and in consultation with the data customers.

Consistent with the site characterization and following a determination of the need for monitoring, the detection-type monitoring prescribed in 20.4.1 NMAC § 264.98 will be initiated. Detection is defined in 20.4.1 NMAC § 264.91(a)(1) as statistically significant evidence of contamination, as described in 20.4.1 NMAC § 264.98(f). A monitoring system and compliance period as described in Attachment A consistent with 20.4.1 NMAC §§ 264.96 and 264.97 will be utilized. In accordance with 20.4.1 NMAC § 264.98(f), LANL will determine whether there is statistically significant evidence of contamination for any chemical parameter or hazardous constituent. An appropriate frequency for sample collection and statistical analysis will be proposed to the NMED that will be capable of determining statistically significant evidence of contamination, as required by 20.4.1 NMAC § 264.98(d). Data will be collected that are appropriate for the statistical methodology applied, sufficient in sample size, and utilizing sampling procedures and frequencies of sample collection established by the Groundwater Protection Program to ensure that potential contaminant release(s) to groundwater from the regulated unit can be detected, in accordance with 20.4.1 NMAC § 264.97. For TA-54, the point of compliance is the boundary of Aggregate 2. If a more comprehensive monitoring program is established, as described in Attachment A consistent with 20.4.1 NMAC § 264.99, and an increase in contamination is indicated, a program that takes action to address the increase will be implemented. Descriptions of each proposed activity equivalent to operating unit regulations for groundwater are presented in Attachment A.

4.2 Maintenance and Frequency

Pursuant to 20.4.1 NMAC § 264.118(b)(2), the planned maintenance activities and the frequencies at which they will be performed are discussed in the following sections. Planned maintenance will include inspections at prescribed frequencies and potential resulting maintenance activities consistent with 20.4.1 NMAC § 264.310. The planned maintenance will also ensure the function of the monitoring equipment consistent with 20.4.1 NMAC, Subpart V, Part 264, Subpart F and 20.4.1 NMAC § 264.310.

4.2.1 Integrity of Cap/Cover

The existing asphalt cover at the Area L regulated unit will be maintained during post-closure to preserve its integrity and effectiveness in accordance with 20.4.1 NMAC § 264.310(b)(1). Inspections of the existing cover will be conducted monthly while treatment and storage operations continue on the surface, and repairs will be made to the existing cover, if necessary, to correct the effects of settling, subsidence, erosion, or other events. After active operations cease, the asphalt cover will be inspected quarterly, unless changes are necessitated by the outcome of investigations currently being conducted under the corrective action program. Inspection results and subsequent repairs will be noted in the facility record. The final selected corrective measure will be maintained to prevent run-on and runoff from eroding or otherwise damaging the selected measure if waste remains in place, consistent with 20.4.1 NMAC § 264.310(b)(5).

4.2.2 Monitoring Equipment

As discussed in Section 4.1.1, LANL will continue to conduct vadose zone monitoring at MDA L and may modify the existing vadose zone monitoring program based on the results of groundwater transport modeling. Continued vadose zone monitoring will allow early detection of potential contaminant transport toward the regional aquifer. The continued vadose zone monitoring will be conducted in lieu of 20.4.1 NMAC § 264.310(b)(2) and (3) requirements, as allowed by the alternative requirements in 20.4.1 NMAC § 264.110(c). Prior to each sampling event, the protective surface casing of each selected borehole will be inspected to ensure that it has not been damaged. The locking mechanisms at each borehole will be checked to verify that they have not been compromised. Vapor ports will also be inspected to ensure that they are not obstructed and have not degraded or lost their plugs. In addition, vapor port depth tags will be inspected for legibility, as will the identification number on the inside of the borehole. Sampling equipment will also be inspected and tested, as necessary, prior to each sampling event. Over time, the monitoring systems that contain the sampling membranes (e.g., socks) within a borehole may require replacement. If the borehole is in an area where vehicle traffic might pose a hazard, the guard or bumper posts will be inspected to ensure their integrity is maintained. Maintenance will be performed on an as-needed basis when the necessity is indicated as a result of inspections.

The groundwater monitoring system, discussed in Section 4.1.2, will also be maintained to ensure maximum operating conditions, consistent with 20.4.1 NMAC § 264.310(b)(4). Prior to each sampling event, the protective steel casing and locking mechanism(s) will be inspected to ensure that they have not been compromised. The well identification number on the inside and/or outside of the cover will also be inspected for legibility. In addition, the brass monument on the concrete protective pad, placed around the well casing to ensure long-term structural integrity of the well, will be inspected to verify that the location identification number remains clearly imprinted on the monument. If the well is in an area where vehicle traffic might pose a hazard, the guard or bumper posts will be inspected to ensure their integrity is maintained. Maintenance will be performed on an as-needed basis when the necessity is indicated as a result of inspections.

Surveyed benchmarks used in accordance with 20.4.1 NMAC § 264.309 will be protected and maintained throughout the post-closure period, pursuant to 20.4.1 NMAC § 264.310(b)(6). If a benchmark is in an area where vehicle traffic might pose a hazard, guard or bumper posts will be installed to provide protection. The condition of the surveyed benchmarks will be inspected for legibility and to identify any potential maintenance needs. Maintenance will be performed on an as-needed basis when the necessity is indicated as a result of inspections.

4.3 Reporting

Post-closure care will also include reporting consistent with 20.4.1 NMAC, Subpart V, Part 264, Subpart F and 20.4.1 NMAC § 264.310, as appropriate.

As described in Attachment A consistent with 20.4.1 NMAC § 264.98, LANL will notify the Secretary of the NMED if, under the detection monitoring program, it is determined [in accordance with 20.4.1 NMAC § 264.98(f)] that there is statistically significant evidence of contamination for chemical parameters or hazardous constituents at any of the Aggregate 2 monitoring wells. This notification will be provided in writing within seven days of the determination. The notification will indicate what chemical parameters or hazardous constituents have shown statistically significant evidence of contamination.

If a more comprehensive monitoring program is established as described in Attachment A consistent with 20.4.1 NMAC § 264.99, LANL will analyze samples from the Aggregate 2 monitoring wells for all 20.4.1 NMAC, Subpart V, Part 264, Appendix IX constituents at least annually, in accordance with 20.4.1 NMAC § 264.99(g). This analysis will be used to determine whether additional hazardous constituents are present in the uppermost aquifer and, if so, at what concentration, pursuant to the procedures in 20.4.1 NMAC § 264.98(f). If LANL finds Appendix IX constituents in the groundwater that are not identified as monitoring constituents in the permit, LANL may resample within one month and repeat the Appendix IX analysis. If the presence of new hazardous constituents is confirmed by the second analysis, LANL will report the concentration of these additional constituents to the Secretary of the NMED within seven days after completion of the second analysis. If LANL decides not to resample, the concentrations of the additional hazardous constituents will be reported to the Secretary of the NMED within seven days after completion of the initial analysis. In either event, these hazardous constituents will be added to the monitoring list.

If a compliance monitoring program is established in accordance with 20.4.1 NMAC, Subpart V, Part 264, Subpart F and LANL determines, pursuant to 20.4.1 NMAC § 264.99(d), that any concentration limits under 20.4.1 NMAC § 264.94 are being exceeded at any of the Aggregate 2 monitoring wells, notification to the Secretary of the NMED will be submitted in writing within seven days. Pursuant to 20.4.1 NMAC § 264.99(h)(1), the notification will indicate which concentration limits have been exceeded.

If a compliance monitoring program is established in accordance with 20.4.1 NMAC, Subpart V, Part 264, Subpart F and LANL determines, pursuant to 20.4.1 NMAC § 264.99(d), that the groundwater concentration limits are being exceeded at any of the Aggregate 2 monitoring wells, LANL may demonstrate that a source other than a regulated unit caused the contamination or that the detection is an artifact caused by an error in sampling, analysis, or statistical evaluation or natural variation in the groundwater. In this case, LANL will notify the Secretary of the NMED within seven days that a demonstration will be made, in accordance with 20.4.1 NMAC § 264.99(i).

If a groundwater corrective action program is established pursuant to 20.4.1 NMAC, Subpart V, Part 264, Subpart F, LANL will report in writing to the Secretary of the NMED on the effectiveness of the program. LANL will submit these reports semiannually, in accordance with 20.4.1 NMAC § 264.100(g).

4.4 Post-Closure Use of Property

In accordance with 20.4.1 NMAC § 264.117(c), post-closure use of property on or in which hazardous waste remains after partial or final closure will not be allowed to disturb the integrity of the final cover or any other components of the containment system, if present. In addition, post-closure use of property will not be allowed to disturb the function of the monitoring systems unless the Secretary of the NMED finds that the disturbance is necessary to the proposed use of the property and will not increase the potential hazard to human health or the environment, or it is necessary to reduce a threat to human health or the environment.

4.5 Post-Closure Care Period Contact Office

As required by 20.4.1 NMAC § 264.118(b)(3), the name, address, and phone number of the office to contact about the Area L landfill during the post-closure care period is:

U.S. Department of Energy
National Nuclear Security Administration
Office of Los Alamos Site Operations
528 35th Street
Los Alamos, New Mexico
87544
505-667-5105

5.0 REFERENCES

EPA, 1998, "Standards Applicable to Owners and Operators of Closed and Closing Hazardous Waste Management Facilities: Post-Closure Permit Requirement and Closure Process; Final Rule," *Federal Register*, pp. 56710-56735.

ER Project, 2001, "Quarterly Technical Report July-September 2001," LA-UR-01-6148, Los Alamos National Laboratory, Los Alamos, New Mexico.

IT Corporation, 1987, "Hydrogeologic Assessment of Technical Area 54, Areas G and L," Los Alamos, New Mexico.

LANL, 2002, "RFI Report for Material Disposal Area L at Technical Area 54," in preparation, Los Alamos National Laboratory, Los Alamos, New Mexico.

LANL, 2001, "Los Alamos National Laboratory General Part A Permit Application," Revision 0.0/0.1/1.0/2.0, Los Alamos National Laboratory, Los Alamos, New Mexico.

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LANL, 1998b, "Hydrogeologic Workplan," May 1998, Los Alamos National Laboratory, Los Alamos, New Mexico.

LANL, 1992a, "RFI Work Plan for Operable Unit 1148," LA-UR-92-855, Los Alamos National Laboratory, Los Alamos, New Mexico.

LANL, 1992b, "Closure Report: Technical Area 54 Waste Oil Storage Tanks," Los Alamos National Laboratory, Los Alamos, New Mexico.

LANL, 1986, "Closure and Post-Closure Plan for TA-54 Area H and Area L Landfill at Los Alamos National Laboratory," November 1986, Los Alamos National Laboratory, Los Alamos, New Mexico.

Stauffer, P., K. Birdsell, M. Witkowski, T. Cherry, and J. Hopkins, 2000, "Subsurface Vapor-Phase Transport of TCA at MDA L: Model Predictions" LA-UR-00-2080, Los Alamos National Laboratory, Los Alamos, New Mexico.

Table 1

Schedule for Closure Activities at Technical Area 54 Area L Landfill

Activity	Maximum Time Required[a]
Let contract request for proposals	-90 Days
Notify the New Mexico Environment Department (NMED)	-45 Days
Receive proposals	-30 Days
Select contractor and award contract	-10 Days
Approval of closure plan	Day 0
Submit closure certification to the NMED	Day 180

[a] The schedule above indicates calendar days from the beginning by which activities will be completed. Some activities may be conducted simultaneously, may not require the maximum time listed, or may require more time than indicated above. Extensions to the schedule may be requested, as needed.

Table 2

Dates of Use, Dimensions, Capacities, and Contents of Shafts 1, 13-17, and 19-34 at Technical Area 54 Area L Landfill

Shaft No.	Start Date of Use	End Date of Use	Depth (feet)	Diameter (feet)	Capacity (cubic feet)	Waste Contents
1	4/80	8/83	60	3	424	Organics
13	6/79	4/82	60	8	3016	Inorganics
14	6/79	4/82	60	3	424	Reactives
15	6/79	4/82	60	3	424	Reactives
16	6/79	4/82	60	3	424	Gas Cylinders
17	6/79	4/82	60	3	424	Organics
19	4/80	4/82	60	8	3016	Waste Oil
20	3/82	8/83	60	3	424	Inorganics
21	3/82	12/85	60	3	424	Gas Cylinders
22	3/82	8/83	60	3	424	Organics
23	4/82	2/84	60	4	754	Waste Oil
24	4/82	3/84	60	4	754	Organics & Waste Oil
25	9/82	4/85	60	6	1696	Inorganics
26	9/82	2/84	60	6	1696	Organics
27	1/83	1/85	60	4	754	Special Waste[a]
28	1/82	4/85	60	4	754	Special Waste
29	12/83	7/84	65	6	1838	Organics
30	12/83	4/84	65	6	1838	Organics
31	12/83	8/84	61	6	1725	Organics
32	3/84	8/84	15	4	188	Organics
33	3/84	1/85	65	6	1838	Organics
34	2/85	4/85	63	6	1781	Organics

[a] Used for miscellaneous wastes requiring greater isolation.

ATTACHMENT A

MDA L

OPERATING UNIT REGULATIONS FOR GROUND WATER/CLOSURE/POST-CLOSURE CARE AND CORRESPONDING HSWA ACTIVITIES

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.90	Applicability		
§264.90(a)(1)	Except as provided in paragraph (b) of this section, the regulations in this subpart apply to owners or operators of facilities that treat, store or dispose of hazardous waste. The owner/operator must satisfy the requirements identified in paragraph (a)(2) of this section for all wastes (or constituents thereof) contained in solid waste management units at the facility, regardless of the time at which waste was placed in such units.		
§264.90(a)(2)	All solid waste management units must comply with the requirements in §264.101. A surface impoundment, waste pile, and land treatment unit or landfill that receives hazardous waste after July 26, 1982 (hereinafter referred to as a "regulated unit") must comply with the requirements of §§264.91 through 264.100 in lieu of §264.101 for purposes of detecting, characterizing and responding to releases to the uppermost aquifer. The financial responsibility requirements of §264.101 apply to regulated units.		
§264.90(b)	The owner/operator's regulated unit or units are not subject to regulation for releases into the uppermost aquifer under this subpart if:		
§264.90(b)(1)	The owner/operator is exempted under §264.1; or	NA	NA
§264.90(b)(2)	He operates a unit which the Secretary finds:	NA	NA
§264.90(b)(2)(i)	Is an engineered structure,	NA	NA
§264.90(b)(2)(ii)	Does not receive or contain liquid waste or waste containing free liquids,	NA	NA
§264.90(b)(2)(iii)	Designed and operated to exclude liquid, precipitation, and other run-on and run-off,	NA	NA
§264.90(b)(2)(iv)	Has inner and outer layers of containment enclosing the waste,	NA	NA
§264.90(b)(2)(v)	Has a leak detection system built into each containment layer,	NA	NA
§264.90(b)(2)(vi)	Continuing operation and maintenance of leak detection systems will be provided during active life and during closure/post-closure care periods, and	NA	NA
§264.90(b)(2)(vii)	To reasonable degree of certainty, will not allow hazardous constituents to migrate beyond outer containment layer prior to end of post-closure care period.	NA	NA
§264.90(b)(3)	The Secretary finds, pursuant to §264.280(d), that the treatment zone of a land treatment unit that qualifies as a regulated unit does not contain levels of hazardous constituents that are above background levels of those constituents by an amount that is statistically significant, and if an unsaturated zone monitoring program meeting the requirements of §264.278 has not shown a statistically significant increase in hazardous constituents below the treatment zone during the operating life of the unit. An exemption under this paragraph can only relieve an owner or operator of responsibility to meet the requirements of this subpart during the post-closure care period; or	NA	NA

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.90(b)(4)	The Secretary finds that there is no potential for migration of liquid from a regulated unit to the uppermost aquifer during the active life of the regulated unit (including the closure period) and the post-closure care period specified under §264.117. This demonstration must be certified by a qualified geologist or geotechnical engineer. In order to provide an adequate margin of safety in the prediction of potential migration of liquid, the owner or operator must base any predictions made under this paragraph on assumptions that maximize the rate of liquid migration.	Should sufficient information support this exemption for a regulated unit in the future, the HSWA activity would be equivalent to that prescribed by the exemption.	
§264.90(b)(5)	He designs and operates a pile in compliance with §264.250(c).	NA	NA
§264.90(c)	The regulations under this subpart apply during the active life of the regulated unit (including the closure period). After closure of the regulated unit, the regulations in this subpart:		NA
§264.90(c)(1)	Do not apply if all waste, waste residues, contaminated containment system components, and contaminated subsurface soils removed or decontaminated at closure;	For MDA L, a CMS report will be developed and will address this issue. If appropriate, the report will include a general description of an excavation alternative corrective measure (equivalent to clean closure). If the excavation corrective measure is selected, details will be provided in the approved CMI Plan following permit modification.	
§264.90(c)(2)	Apply during post-closure care period if owner/operator is conducting a detection monitoring program under §264.98; or	The probable corrective measure to be implemented at MDA L will include monitoring in the vadose zone beneath MDA L. The LANL hydrogeologic characterization program (as implemented through the LANL Hydrogeologic Workplan) proposes the locations for characterization wells for TA-54 that after four sampling events will be included in LANL Environmental Surveillance Program, and may, if appropriate, be used as repetitive monitoring wells for TA-54 as a whole.	
§264.90(c)(3)	Apply during compliance period under §264.96 if the owner/operator is conducting a compliance monitoring program under §264.99 or a corrective action program under §264.100.	If monitoring indicates a more comprehensive program is needed to adequately comply with ground water protection standards in 264.91 and 264.92, additional characterization and/or well installation will occur, if appropriate.	

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.90(d)	Regulations in this subpart may apply to miscellaneous units when necessary to comply with §§264.601-603.	NA	NA
§264.90(e)	The regulations of this subpart apply to all owners and operators subject to the requirements of 40 CFR 270.1(c)(7), when the Bureau issues either a post-closure permit or an enforceable document (as defined in 40 CFR 270.1(c)(7)) at the facility. When the Bureau issues an enforceable document, references in this subpart to "in the permit" mean "in the enforceable document."	CMS and CMI plans and resulting CMS and CMI reports describing activities equivalent to post-closure permit requirements will be "enforceable documents" consistent with 265.121.	
§264.90(f)	The Secretary may replace all or part of the requirements of §§ 264.91 through 264.100 applying to a regulated unit with alternative requirements for groundwater monitoring and corrective action for releases to groundwater set out in the permit (or in an enforceable document) (as defined in 40 CFR 270.1(c)(7)) where the Secretary determines that:	Activities proposed and implemented in the above referenced plans will be effectively equivalent to the cited Subpart F requirements.	
§264.90(f)(1)	The regulated unit is situated among SWMUs or areas of concern (AOC), a release has occurred, and both the regulated unit and one or more SWMUs or AOCs are likely to have contributed to the release; and	As the possibility for this situation exists, alternative activities may appropriately replace all or part of the above cited Subpart F requirements.	
§264.90(f)(2)	It is not necessary to apply the groundwater monitoring and corrective action requirements of §§264.91-100 because alternative requirements will protect human health and the environment.	Should the above situation exist, §264.90(f)(1), alternative activities protective of human health and the environment and proposed in lieu of §264.91-264.100 will preclude the need for application of Subpart F requirements.	
§264.91	Required programs		
§264.91(a)	Owner/operators subject to this subpart must conduct a monitoring and response program as follows:		
§264.91(a)(1)	Whenever hazardous constituents under §264.93 from a regulated unit are detected at a compliance point under §264.95, owner/operator must institute a compliance monitoring program under §264.99. Detection is defined as statistically significant evidence of contamination as described in §264.98(f);	If detection is indicated, additional characterization and/or well installation will occur if appropriate - 264.90(c)(3)	
§264.91(a)(2)	Whenever the groundwater protection standard under §264.92 is exceeded, owner/operator must institute a corrective action program under §264.100. Exceedance is defined as statistically significant evidence of increased contamination as described in §264.99(d);	If detection is indicated, concentrations protective of human health and the environment will be established similar to ground water protection standards in §264.92. Actions necessary to correct any exceedances of such concentrations will be taken as necessary.	

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.91(a)(3)	Whenever hazardous constituents under §264.93 from a regulated unit exceed concentration limits under §264.94 in groundwater between the compliance point under §264.95 and the downgradient facility property boundary, owner/operator must institute a corrective action program under §264.100; or	Should established concentration limits be exceeded between the point of compliance and the downgradient boundary, actions to correct such exceedances will be taken as necessary.	
§264.91(a)(4)	In all other cases, owner/operator must institute a detection monitoring program under §264.98.	TA-54 characterization wells will be sampled and analyzed as repetitive monitoring wells as appropriate through the LANL Environmental Surveillance Program.	
§264.91(b)	The Secretary will specify in the facility permit the specific elements of the monitoring and response program. The Secretary may include one or more of the programs identified in paragraph (a) of this section in the facility permit as may be necessary to protect human health and the environment and will specify the circumstances under which each of the programs will be required. In deciding whether to require the owner or operator to be prepared to institute a particular program, the Secretary will consider the potential adverse effects on human health and the environment that might occur before final administrative action on a permit modification application to incorporate such a program could be taken.	See above.	
§264.92	The owner/operator must comply with conditions specified in the facility permit that are designed to ensure that hazardous constituents under §264.93 detected in the ground water from a regulated unit do not exceed the concentration limits under §264.94 in the uppermost aquifer underlying the waste management area beyond the point of compliance under §264.95 during the compliance period under §264.96. The Secretary will establish this ground-water protection standard in the facility permit when hazardous constituents have been detected in the ground water.	Should "detection" consistent with the definition in §264.91(a)(1) occur, LANL will comply with concentration limits established through a process similar to that described in §264.94.	
§264.93	Hazardous constituents		
§264.93(a)	The Secretary will specify in the facility permit the hazardous constituents to which the ground-water protection standard of §264.92 applies. Hazardous constituents are constituents identified in appendix VIII of part 261 of this chapter that have been detected in ground water in the uppermost aquifer underlying a regulated unit and that are reasonably expected to be in or derived from waste contained in a regulated unit, unless the Secretary has excluded them under paragraph (b) of this section.	For any of the following information that is not already available or developed, it will be prepared and included in a manner consistent with §264.93 in corresponding corrective action/HSWA activity documents.	

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.93(b)	The Secretary will exclude an Appendix VIII constituent from the list of hazardous constituents specified in the facility permit if he finds that the constituent is not capable of posing a substantial present or potential hazard to human health or the environment. In deciding whether to grant an exemption, the Secretary will consider the following:	Concentration limits established for hazardous constituents following "detection" will not include those incapable of posing a substantial present or potential hazard to human health or the environment considering the following:	
§264.93(b)(1)	Potential adverse effects on groundwater quality, considering:	Potential adverse effects on groundwater quality considering:	
§264.93(b)(1)(i)	Physical and chemical characteristics of waste in the regulated unit, including its potential for migration;	Detailed information on waste inventory and chemical characteristics for Shafts 1, 13-17, and 19-34 and Impoundments B and D will be presented in the MDA L RFI Report and CMS Report including potential for migration and site conceptual model.	
§264.93(b)(1)(ii)	Hydrogeologic characteristics of the facility and surrounding land;	While this information regarding the hydrogeologic characterization of the facility and surrounding land is being developed through the implementation of the Hydrogeologic Workplan, site specific information for MDA L will be presented in the MDA L RFI Report and MDA L CMS Report.	
§264.93(b)(1)(iii)	Quantity of groundwater and the direction of groundwater flow;	Information regarding quantity and direction of flow of groundwater can be obtained through the LANL Hydrogeologic Work Plan.	
§264.93(b)(1)(iv)	Proximity and withdrawal rates of groundwater users;	Information regarding the proximity and withdrawal rates of ground-water users can be obtained in the annual water supply reports (with location maps) published by ESH-18, in sections 270.14(e), 264(b)(1)(iv) and 264.601(a)(5) of the LANL permit, or in previous LANL waiver documentation.	
§264.93(b)(1)(v)	Current and future uses of groundwater in the area;	Information regarding current and future users of groundwater in the area will be developed.	

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.93(b)(1)(vi)	Existing quality of groundwater, including other sources of contamination and their cumulative impact on groundwater quality;	Four sampling events for each well installed in the vicinity of TA-54 pursuant to the Hydrogeologic Workplan will occur in addition to ongoing monitoring of Environmental Surveillance Program wells and ER site characterization efforts.	
§264.93(b)(1)(vii)	Potential health risks caused by human exposure to waste constituents;	A present day human health risk screening assessment was completed and is presented in Attachment C of the Area L closure/post-closure plan. Results indicate no unacceptable risk to human receptors. The CMS Report for MDA L will provide results of a future human health risk assessment, including potential for contaminant migration and the site conceptual model.	Attachment C
§264.93(b)(1)(viii)	Potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to waste constituents;	A present day ecological risk screening assessment was completed and is presented in Attachment C of the Area L closure/post-closure plan. Results indicate no unacceptable risk to ecological receptors. The CMS Report for MDA L will provide results of a future ecological risk assessment, including potential for contaminant migration and the site conceptual model.	Attachment C
§264.93(b)(1)(ix)	Persistence and permanence of the potential adverse effects; and	RFI and CMS Reports for MDA L will be developed and will address this issue.	
§264.93(b)(2)	Potential adverse effects on hydraulically-connected surface water quality, considering:	Potential adverse effects on hydraulically-connected surface water quality, considering:	
§264.93(b)(2)(i)	Volume and physical and chemical characteristics of the waste in the regulated unit;	RFI and CMS Reports for MDA L will be developed and will address this issue.	

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.93(b)(2)(ii)	Hydrogeologic characteristics of the facility and surrounding land;	While additional information regarding the hydrogeologic characterization of the facility and surrounding land is being developed through the implementation of the Hydrogeologic Work Plan, information for MDA L can also be found in the Performance Assessment, the Hydrogeologic Assessment of TA-54, Areas G and L, and will be presented in the MDA L RFI and CMS Reports.	
§264.93(b)(2)(iii)	Quantity and quality of groundwater, and the direction of groundwater flow;	Information to be obtained through implementation of the LANL Hydrogeologic Workplan.	
§264.93(b)(2)(iv)	Rainfall patterns in the region;	RFI and CMS Reports for MDA L will be developed and will address this issue.	
§264.93(b)(2)(v)	Proximity of regulated unit to surface waters;	RFI and CMS Reports for MDA L will be developed and will address this issue.	
§264.93(b)(2)(vi)	Current and future uses of surface waters in the area and any water quality standards established for those surface waters;	Information regarding surface water use, if not already described, will be developed.	
§264.93(b)(2)(vii)	Existing quality of surface water, including other sources of contamination and the cumulative impact on surface water quality;	The evaluation of LANL's surface water quality standards are considered in the evaluation of surface water and springs by the LANL Environmental Surveillance Program multi-sector CWA permit, as well as through ER Project characterization activities.	
§264.93(b)(2)(viii)	Potential for health risks caused by human exposure to waste constituents;	RFI and CMS Reports for MDA L will be developed and will address this issue.	
§264.93(b)(2)(ix)	Potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to waste constituents; and	RFI and CMS Reports for MDA L will be developed and will address this issue.	
§264.93(b)(2)(x)	Persistence and permanence of potential adverse effects.	RFI and CMS Reports for MDA L will be developed and will address this issue.	
§264.93(c)	In making any determination under paragraph (b) of this section about the use of ground water in the area around the facility, the Secretary will consider any identification of underground sources of drinking water and exempted aquifers made under §144.8 of this chapter.	NA	
§264.94	Concentration limits		

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.94(a)	The Secretary will specify in the facility permit the concentration limits in the groundwater for hazardous constituents established under §264.93. The concentration of a hazardous constituent:	Proposed concentration limits of detected hazardous constituents will be consistent with evaluation of parameters set forth in 264.94. To the extent that information necessary to establish provisions of this section do not already exist, they will be developed. Otherwise this information will be found in the previously identified documents.	
§264.94(a)(1)	Must not exceed background level of that constituent in the groundwater at the time that limit is specified in the permit; or	See above.	
§264.94(a)(2)	For any constituent listed in §264.94, Table 1, must not exceed the respective value given in that table if the background level of the constituent is below the value given in Table 1; or	See above.	
§264.94(a)(3)	Must not exceed an alternate limit established by the Secretary under paragraph (b) of this section.	See above.	
§264.94(b)	The Secretary will establish an alternate concentration limit for a hazardous constituent if he finds that the constituent will not pose a substantial present or potential hazard to human health or the environment as long as the alternate concentration limit is not exceeded. In establishing alternate concentration limits, the Secretary will consider the following factors:	See above.	
§264.94(b)(1)	Potential adverse effects on groundwater quality, considering:		
§264.94(b)(1)(i)	Physical and chemical characteristics of the waste in the regulated unit, including its potential for migration;	RFI and CMS Reports for MDA L will be developed and will address this issue.	
§264.94(b)(1)(ii)	Hydrogeological characteristics of the facility and surrounding land;	While this information regarding the hydrogeologic characterization in facility and surrounding land is being developed through the implementation of the Hydrogeologic Workplan, site-specific information for MDA L will be found in the MDA L RFI Report and CMS Report.	
§264.94(b)(1)(iii)	Quantity of groundwater and direction of groundwater flow;	Information to be obtained through implementation of the LANL Hydrogeologic Workplan.	

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.94(b)(1)(iv)	Proximity and withdrawal rates of groundwater users;	Information regarding the proximity and withdrawal rates of ground-water users can be obtained in the annual water supply reports (with location maps) published by ESH-18, in sections 270.14(e), 264(b)(1)(iv) and 264.601(a)(5) of the LANL permit, or in previous LANL waiver documentation.	
§264.94(b)(1)(v)	Current and future uses of groundwater in the area;	Information regarding current and future users of groundwater in the area will be developed.	
§264.94(b)(1)(vi)	Existing quality of groundwater, including other sources of contamination and their cumulative impact on groundwater quality;	Four sampling events for each well installed in the vicinity of TA-54 pursuant to the Hydrogeologic Workplan will occur in addition to ongoing monitoring of Environmental Surveillance Program wells and ER Project site characterization efforts.	
§264.94(b)(1)(vii)	Potential for health risks caused by human exposure to waste constituents;	A present day human health risk screening assessment was completed and is presented in Attachment C of the Area L closure/post-closure plan. Results indicate no unacceptable risk to human receptors. The CMS Report for MDA L will provide results of a future human health risk assessment, including potential for contaminant migration and the site conceptual model.	
§264.94(b)(1)(viii)	Potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to waste constituents;	A present day ecological risk screening assessment was completed and is presented in Attachment C of the Area L closure/post-closure plan. Results indicate no unacceptable risk to ecological receptors. The CMS Report for MDA L will provide results of a future ecological risk assessment, including potential for contaminant migration and the site conceptual model.	
§264.94(b)(1)(ix)	Persistence and permanence of potential adverse effects; and	RFI and CMS Reports for MDA L will be developed and will address this issue.	

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.94(b)(2)	Potential adverse effects on hydraulically-connected surface water quality, considering:	Potential adverse effects on hydraulically-connected surface water quality, considering:	
§264.94(b)(2)(i)	Volume and physical and chemical characteristics of the waste in the regulated unit;	RFI and CMS Reports for MDA L will be developed and will address this issue.	
§264.94(b)(2)(ii)	Hydrogeological characteristics of the facility and surrounding land;	While this information regarding the hydrogeologic characterization of the facility and surrounding land is being developed through the implementation of the Hydrogeologic Workplan, site-specific information for MDA L will be presented in the MDA L RFI Report and CMS Report.	
§264.94(b)(2)(iii)	Quantity and quality of groundwater and direction of groundwater flow;	Information to be obtained through implementation of the LANL Hydrogeologic Workplan.	
§264.94(b)(2)(iv)	Patterns of rainfall in the region;	RFI and CMS Reports for MDA L will be developed and will address this issue.	
§264.94(b)(2)(v)	Proximity of regulated unit to surface waters;	RFI and CMS Reports for MDA L will be developed and will address this issue.	
§264.94(b)(2)(vi)	Current and future uses of surface waters in the area and any water quality standards established for those surface waters;	Information regarding surface water use, if not already described, will be developed.	
§264.94(b)(2)(vii)	Existing surface water quality, including other sources of contamination and their cumulative impact on surface water quality;	The evaluation of LANL's surface water quality standards are considered in the evaluation of surface water and springs by the LANL Environmental Surveillance Program multi-sector CWA permit, as well as through ER Project characterization activities.	
§264.94(b)(2)(viii)	Potential for health risks caused by human exposure to waste constituents;	A present day human health risk screening assessment was completed and is presented in Attachment C of the Area L closure/post-closure plan. Results indicate no unacceptable risk to human receptors. The CMS Report for MDA L will provide results of a future human health risk assessment, including potential for contaminant migration and the site conceptual model.	

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.94(b)(2)(ix)	Potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to waste constituents; and	A present day ecological risk screening assessment was completed and is presented in Attachment C of the Area L closure/post-closure plan. Results indicate no unacceptable risk to ecological receptors. The CMS Report for MDA L will provide results of a future ecological risk assessment, including potential for contaminant migration and the site conceptual model.	
§264.94(b)(2)(x)	Persistence and permanence of potential adverse effects.	RFI and CMS Reports for MDA L will be developed and will address this issue.	
§264.94(c)	In making any determination under paragraph (b) of this section about the use of ground water in the area around the facility the Secretary will consider any identification of underground sources of drinking water and exempted aquifers made under §144.8 of this chapter.	NA	
§264.95	Point of compliance	In establishing a point of compliance, the limits of the waste management area can be delineated by circumscribing an imaginary line around more than one unit. The aggregate approach used in the Hydrogeologic Workplan was intended to be consistent with this concept. As characterization efforts progress, the appropriateness of the aggregate boundary for TA-54 will be assessed.	
§264.95(a)	The Secretary will specify in the facility permit the point of compliance at which the groundwater protection standard of §264.92 applies and at which monitoring must be conducted. The point of compliance is a vertical surface located at the hydraulically downgradient limit of the waste management area that extends down into the uppermost aquifer underlying the regulated units.	See above. The point of compliance is a vertical surface located at the hydraulically downgradient limit of the aggregate that extends down into the uppermost aquifer underlying the regulated units.	
§264.95(b)	The waste management area is the limit projected in horizontal plane of the area on which waste will be placed during active life of regulated unit.	See above.	
§264.95(b)(1)	The waste management area includes horizontal space taken up by any liner, dike, or other barrier designed to contain waste in a regulated unit.	NA	
§264.95(b)(2)	If facility contains more than one regulated unit, the waste management area is described by an imaginary line circumscribing the several regulated units.	See above.	
§264.96	Compliance period		

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.96(a)	The Secretary will specify in the facility permit the compliance period during which the ground-water protection standard of §264.92 applies. The compliance period is the number of years equal to the active life of the waste management area (including any waste management activity prior to permitting, and the closure period.)	The implementing document for these alternative activities will specify the period during which concentration limits similar groundwater protection standards and will be equivalent to the remaining active life (including closure period) of the waste management area.	
§264.96(b)	The compliance period begins when the owner/operator initiates a compliance monitoring program meeting requirements of §264.99.	This period will begin upon detection as defined in 264.91, and, if a more comprehensive program is needed to adequately address concentration limits, additional characterization and/or monitoring well installation will occur if appropriate.	
§264.96(c)	If the owner/operator is engaged in a corrective action program at the end of the compliance period specified in paragraph (a) of this section, the compliance period is extended until the owner/operator can demonstrate that the ground-water protection standard of § 264.92 has not been exceeded for a period of three consecutive years.	This period will be established for a period of 3 years if, at the end of the active life and closure period, the concentration limits described above continue to be exceeded.	
§264.97	The owner/operator must comply with following requirements for any groundwater monitoring program developed to satisfy §264.98, §264.99, or §264.100:	Alternative requirements will be met there.	
§264.97(a)	The groundwater monitoring system must consist of sufficient number of wells, installed at appropriate locations and depths to yield groundwater samples from the uppermost aquifer that:	All groundwater monitoring wells will be sufficient in number and placed at appropriate locations and depths in the uppermost aquifer as determined by characterization efforts performed during implementation of the Hydrogeologic Workplan.	
§264.97(a)(1)	Represent the quality of background water that has not been affected by leakage from a regulated unit;	Background wells will be placed in an upgradient locations determined to be unaffected by potential releases from the waste management area.	

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.97(a)(1)(i)	A determination of background quality may include sampling of wells that are not hydraulically upgradient of the waste management area where:	Should existing conditions preclude the location of background wells upgradient, other wells will be used. These wells will be capable of determining background quality passing the aggregate boundary. This determination will be made in part by ongoing characterization efforts establishing groundwater gradient, flow directions, potential transport mechanisms, and waste-specific migration characteristics.	
§264.97(a)(1)(i)(A)	Hydrogeologic conditions do not allow the owner/operator to determine what wells are hydraulically upgradient; and	See above.	
§264.97(a)(1)(i)(B)	Sampling at other wells will provide an indication of background groundwater quality that is representative or more representative than that provided by the upgradient wells; and	See above.	
§264.97(a)(2)	Represent the quality of groundwater passing the point of compliance.	The above-mentioned geologic, hydrologic, and waste characteristics will be considered in determining the representativeness of the groundwater passing the downgradient aggregate boundary and the monitoring system's capability of detecting contamination if hazardous waste or hazardous constituents migrate from the aggregate to the uppermost aquifer.	
§264.97(a)(3)	Allow for the detection of contamination when hazardous waste or hazardous constituents have migrated from the waste management area to the uppermost aquifer.	See above.	
§264.97(b)	If a facility contains more than one regulated unit, separate groundwater monitoring systems are not required for each unit provided that provisions for sampling the groundwater in the uppermost aquifer will enable detection and measurement at the compliance point of hazardous constituents from the regulated units that have entered groundwater in the uppermost aquifer.	Consistent with establishing a point of compliance by circumscribing an imaginary line around more than one unit, a groundwater monitoring system capable of detecting and measuring hazardous constituents at the aggregate boundary will meet the intent of this requirement.	

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.97(c)	All monitoring wells must be cased in a manner that maintains the integrity of the monitoring-well bore hole. This casing must be screened or perforated and packed with gravel or sand, where necessary, to enable collection of ground water samples. The annular space (i.e., the space between the borehole and well casing) above the sampling depth must be sealed to prevent contamination of samples and the groundwater.	The integrity of the monitoring well borehole will be maintained by casing in a manner most appropriate for the use and surrounding subsurface environment. Screen materials should be selected based on compatibility with geochemistry and long-term structural integrity. Well casing size should be determined based on the size of purging and equipment necessary to sample the well and the depth of the well. Filter pack material should be inert (i.e., silica sand). Gravel filters are acceptable pending sieve analysis. Annular space should be sealed with materials chemically compatiable with the anticipated contaminants and have a permeability one to two orders of magnitude less than the surrounding formation. A cement and bentonite mixture, bentonite chips, or antishrink cement mixtures can be used in the unsaturated zone and below the frost line. The cap should consist of concrete blending into an apron extending at least three feet from the outer edge of the borehole. Remaining annular space should be sealed with expanding cement. A suitable threaded or flanged cap or compression seal should then be placed and locked. A quarter-inch vent hole pipe will allow gas to escape, and bumper guards should be placed around the well to prevent damage by vehicles.	
§264.97(d)	The groundwater monitoring program must include consistent sampling and analysis procedures that are designed to ensure monitoring results provide a reliable indication of groundwater quality below the waste management area. At a minimum, the program must include procedures and techniques for:	Groundwater sampling and analysis procedures will be in written form and will address the following:	

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.97(d)(1)	Sample collection;	1) Groundwater level measurements will be determined prior to collection of sample in accordance with a written procedure describing level of accuracy, measurement reference points, required equipment decontamination, and time period measured. 2) Water collection will occur in accordance with a written procedure describing sampling devices and procedures for use and decontamination, well evacuation volumes and procedures, field measurements, and appropriate sample container types.	
§264.97(d)(2)	Sample preservation and shipment;	*SW-846* requirements will be followed to ensure appropriate preservation and temperature controls are utilized.	
§264.97(d)(3)	Analytical procedures; and	*SW-846* or other approved analytical methods, holding times, and approved QA/QC analytical procedures will be used.	
§264.97(d)(4)	Chain-of-Custody control.	Chain-of-custody will include: sample number, time, and date; collector's signature; sample type; well identification; number of containers; parameters to be analyzed; signatures of subsequent handlers; inclusive dates of possession; storage temperature at shipment and receipt; and verification of temperature control upon receipt at analytical laboratory.	
§264.97(e)	The groundwater monitoring program must include sampling and analytical methods appropriate for groundwater sampling and that accurately measure hazardous constituents in groundwater samples.	See above.	
§264.97(f)	The groundwater monitoring program must include determination of the groundwater surface elevation each time the water is sampled.	Groundwater levels will be determined each time water is sampled.	

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.97(g)	In detection monitoring or where appropriate in compliance monitoring, data on each hazardous constituent specified in the permit will be collected from background wells and wells at the compliance point(s). The number and kinds of samples collected to establish background shall be appropriate for the form of statistical test employed, following generally accepted statistical principles. Sample size shall be as large as necessary to ensure with reasonable confidence that a contaminant release to ground water from a facility will be detected. The owner or operator will determine an appropriate sampling procedure and interval for each hazardous constituent listed in the facility permit which shall be specified in the unit permit upon approval by the Secretary. The sampling procedure shall be:	Data will be collected that are appropriate for the statistical methodology applied, sufficient in sample size, and utilizing sampling procedures and frequencies of sample collection to ensure that potential contaminant release(s) to groundwater from the waste management unit(s) can be detected.	
§264.97(g)(1)	A sequence of at least four samples, taken at an interval that assures, to the greatest extent technically feasible, that an independent sample is obtained, by reference to the uppermost aquifer's effective porosity, hydraulic conductivity, and hydraulic gradient, and the fate and transport characteristics of the potential contaminants, or	An adequate number of samples will be collected at appropriate frequencies to ensure representativeness considering aquifer and potential contaminant characteristics. Information such as retardation potential for metals and organics and transport time based on groundwater velocity and constituent mobility will be considered in developing the sampling procedure.	
§264.97(g)(2)	An alternate sampling procedure proposed by the owner/operator and approved by the Secretary.	Should an alternative to the sampling procedure described above be more appropriate, it will be proposed.	
§264.97(h)	Owner/operator will specify one of the following statistical methods to be used in evaluating ground-water monitoring data for each hazardous constituent which will be specified in the unit permit. The statistical test chosen shall be conducted separately for each hazardous constituent in each well. Where practical quantification limits (pql's) are used in any of the following statistical procedures to comply with §264.97(i)(5), the pql must be proposed by the owner or operator and approved by the Secretary. Use of any of the following statistical methods must be protective of human health and the environment and must comply with the performance standards outlined in paragraph (i) of this section.	One of the statistical methods described in §264.97(h) or an alternative approved by the Secretary will be chosen to evaluate groundwater monitoring data. It is premature at this time to prescribe a specific method until adequate characterization has been performed.	
§264.97(h)(1)	A parametric analysis of variance (ANOVA) followed by multiple comparisons procedures to identify statistically significant evidence of contamination. The method must include estimation and testing of the contrasts between each compliance well's mean and the background mean levels for each constituent.	See above.	

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.97(h)(2)	An analysis of variance (ANOVA) based on ranks followed by multiple comparisons procedures to identify statistically significant evidence of contamination. The method must include estimation and testing of the contrasts between each compliance well's median and the background median levels for each constituent.	See above.	
§264.97(h)(3)	A tolerance or prediction interval procedure in which an interval for each constituent is established from the distribution of the background data, and the level of each constituent in each compliance well is compared to the upper tolerance or prediction limit.	See above.	
§264.97(h)(4)	A control chart approach that gives control limits for each constituent.	See above.	
§264.97(h)(5)	Another statistical test method submitted by the owner or operator and approved by the Secretary.	See above.	
§264.97(i)	Any statistical method chosen under §264.97(h) for specification in the unit permit shall comply with the following performance standards, as appropriate:	The appropriate performance standard used for the statistical method applied will be consistent with those prescribed in §264.97(i).	
§264.97(i)(1)	The statistical method used to evaluate ground-water monitoring data shall be appropriate for the distribution of chemical parameters or hazardous constituents. If the distribution of the chemical parameters or hazardous constituents is shown by the owner or operator to be inappropriate for a normal theory test, then the data should be transformed or a distribution-free theory test should be used. If the distributions for the constituents differ, more than one statistical method may be needed.	See above.	
§264.97(i)(2)	If an individual well comparison procedure is used to compare an individual compliance well constituent concentration with background constituent concentrations or a ground-water protection standard, the test shall be done at a Type I error level no less than 0.01 for each testing period. If a multiple comparisons procedure is used, the Type I experimentwise error rate for each testing period shall be no less than 0.05; however, the Type I error of no less than 0.01 for individual well comparisons must be maintained. This performance standard does not apply to tolerance intervals, prediction intervals or control charts.	See above.	
§264.97(i)(3)	If a control chart approach is used to evaluate ground-water monitoring data, the specific type of control chart and its associated parameter values shall be proposed by the owner or operator and approved by the Secretary if he or she finds it to be protective of human health and the environment.	See above.	

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.97(i)(4)	If a tolerance interval or a prediction interval is used to evaluate groundwater monitoring data, the levels of confidence and, for tolerance intervals, the percentage of the population that the interval must contain, shall be proposed by the owner or operator and approved by the Secretary if it finds these parameters to be protective of human health and the environment. These parameters will be determined after considering the number of samples in the background data base, the data distribution, and the range of the concentration values for each constituent of concern.	See above.	
§264.97(i)(5)	The statistical method shall account for data below the limit of detection with one or more statistical procedures that are protective of human health and the environment. Any practical quantification limit (pql) approved by the Secretary under §264.97(h) that is used in the statistical method shall be the lowest concentration level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions that are available to the facility.	See above.	
§264.97(i)(6)	If necessary, the statistical method shall include procedures to control or correct for seasonal and spatial variability as well as temporal correlation in the data.	See above.	
§264.97(j)	Ground-water monitoring data collected in accordance with paragraph (g) of this section including actual levels of constituents must be maintained in the facility operating record. The Secretary will specify in the permit when the data must be submitted for review.	Groundwater monitoring data obtained will be maintained in the facility records.	
§264.98	An owner/operator required to establish a detection monitoring program under this subpart must, at a minimum, discharge the following responsibilities:	Upon completion of adequate characterization through the Hydrogeologic Workplan, and a determination that monitoring would be appropriate, the detection-type monitoring prescribed in §264.98 would be initiated.	
§264.98(a)	The owner/operator must monitor for indicator parameters (e.g., specific conductance, total organic carbon, or total organic halogen), waste constituents, or reaction products that provide a reliable indication of the presence of hazardous constituents in ground water. The Secretary will specify the parameters or constituents to be monitored in the facility permit, after considering the following factors:	As a result of sampling performed during the four events following well installation under the Hydrogeologic Workplan, indicator parameters, waste constituents, or reaction products will be prescribed that consider the following:	
§264.98(a)(1)	The types, quantities, and concentrations of constituents in wastes managed at the regulated unit;	Waste information has been obtained and reviewed, identifying hazardous constituents, concentrations, and waste volumes during the RFI/CMS process.	

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.98(a)(2)	The mobility, stability, and persistence of waste constituents or their reaction products in the unsaturated zone beneath the waste management area;	Further refinement of the hydrogeologic regime at TA-54 and the behavior of hazardous constituents in the unsaturated zone will be developed and reported through the Hydrogeologic Workplan activities and the RFI/CMS process. Substantial information regarding these issues has already been provided in the "Hydrogeologic Assessment of Technical Area 54, Areas G and L", the "Performance Assessment and Composite Analysis for Los Alamos National Laboratory Material Disposal Area G", and the "RFI Report for Material Disposal Areas G, H and L at Technical Area 54".	
§264.98(a)(3)	The detectability of indicator parameters, waste constituents, and reaction products in ground water; and	Based on data collected during the four sampling events following well installation under the Hydrogeologic Workplan, detectability of indicator parameters, waste constituents, and reaction products will be established using *SW-846* or Secretary-approved methodologies and detection limits.	
§264.98(a)(4)	The concentrations or values and coefficients of variation of proposed monitoring parameters or constituents in ground-water background values.	Considerations for establishing concentrations and coefficients of varience of background parameters or constituents include: location of the unit, groundwater flow direction, depth to groundwater, appropriate number and location of background wells, available geologic and hydrologic information, drilling methods, well installation details, and sampling data.	

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.98(b)	Owner/operator must install a ground-water monitoring system at the compliance point as specified under §264.95. The ground-water monitoring system must comply with §264.97(a)(2), (b), and (c).	Should it be determined that a groundwater monitoring system will be necessary, installation of this system will consider: location data, geology and hydrology, drilling methods, flow direction and velocity, potential contaminant behavior, and well completion and development details. Much of this information for TA-54 has been developed already in the Hydrogeologic Assessment of TA-54, Areas L and G, the Performance Assessment, and the RFI Reports for MDAs G, H and L and will continue through ongoing efforts of the Hydrogeologic Work Plan and the CMS/CMI process. The system will be capable of collecting groundwater samples from wells constructed and located in such a manner so as to be representative of the quality of groundwater passing beneath TA-54 at the aggregate boundary. Vadose zone investigation including delineation of contaminant movement and potential impact can be used to enhance and/or supplement monitoring efforts as an early detection mechanism.	
§264.98(c)	The owner/operator must conduct ground-water monitoring for each chemical parameter and hazardous constituent specified in the permit pursuant to paragraph (a) of this section in accordance with §264.97(g), and maintain a record of ground-water analytical data as measured and in a form necessary for the determination of statistical significance under §264.97(h).	Samples will be collected and analyzed for all relevant chemical parameters and hazardous constituents in such form as is appropriate for determination of statistical significance.	
§264.98(d)	The Secretary will specify the frequencies for collecting samples and conducting statistical tests to determine whether there is statistically significant evidence of contamination for any parameter or hazardous constituent specified in the permit under paragraph (a) of this section in accordance with §264.97(g). A sequence of at least four samples from each well (background and compliance wells) must be collected at least semi-annually during detection monitoring.	An appropriate frequency for sample collection and statistical analysis will be proposed that will be capable of determining statistically significant evidence of contamination as described in §264.98(d).	
§264.98(e)	The owner/operator must determine the ground-water flow rate and direction in the uppermost aquifer at least annually.	Groundwater flow rate and direction in the upper-most aquifer will be determined and reevaluated annually.	

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.98(f)	The owner/operator must determine whether there is statistically significant evidence of contamination for any chemical parameter of hazardous constituent specified in the permit pursuant to paragraph (a) of this section at a frequency specified under paragraph (d) of this section.	Collect and analyze samples, evaluate data using appropriate statistical methodology and compare groundwater quality between the upgradient and downgradient wells at the aggregate boundary to determine whether statistically significant evidence of contamination exists within a reasonable timeframe.	
§264.98(f)(1)	In determining whether statistically significant evidence of contamination exists, the owner/operator must use the method(s) specified in the permit under §264.97(h). These method(s) must compare data collected at the compliance point(s) to the background ground-water quality data.	See above.	
§264.98(f)(2)	The owner/operator must determine whether there is statistically significant evidence of contamination at each monitoring well as the compliance point within a reasonable period of time after completion of sampling. The facility permit will specify what period of time is reasonable, based on the complexity of the statistical test and the availability of laboratory facilities to perform the analysis of ground-water samples.	See above.	
§264.98(g)	If the owner/operator determines pursuant to paragraph (f) of this section that there is statistically significant evidence of contamination for chemical parameters or hazardous constituents specified pursuant to paragraph (a) of this section at any monitoring well at the compliance point, he or she must:	If statistically significant evidence of contamination for established chemical parameters or hazardous constituents exists, notification will be made and ground water wells will be sampled for Appendix IX constituents. If present and confirmed with a second analysis within the timeframes described in §264.98(g), these constituents will be used in a more comprehensive monitoring program.	
§264.98(g)(1)	Notify the Secretary of this finding in writing within seven days. The notification must indicate what chemical parameters or hazardous constituents have shown statistically significant evidence of contamination;	See above.	
§264.98(g)(2)	Immediately sample the ground water in all monitoring wells and determine whether constituents in the list of Appendix IX of part 264 are present, and if so, in what concentration.	See above.	

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.98(g)(3)	For any Appendix IX compounds found in the analysis pursuant to paragraph (g)(2) of this section, resample within one month and repeat the analysis for those compounds detected. If the results of the second analysis confirm the initial results, then these constituents will form the basis for compliance monitoring. If groundwater is not resampled for the compounds found pursuant to paragraph (g)(2) of this section, the hazardous constituents found during this initial Appendix IX analysis will form the basis for compliance monitoring.	See above.	
§264.98(g)(4)	Within 90 days, submit to the Secretary an application for a permit modification to establish a compliance monitoring program meeting the requirements of §264.99. The application must include the following information:	Within 90 days, a request for modification of an enforceable document will be submitted to establish a more comprehensive monitoring program. It will include:	
§264.98(g)(4)(i)	An identification of the concentration or any Appendix IX constituent detected in the ground water at each monitoring well at the compliance point;	Appendix IX constituents and associated concentrations confirmed in downgradient aggregate boundary wells;	
§264.98(g)(4)(ii)	Any proposed changes to the ground-water monitoring system at the facility necessary to meet the requirements of §264.99;	Any proposed modifications/enhancements to the existing groundwater monitoring system if necessary:	
§264.98(g)(4)(iii)	Any proposed additions or changes to the monitoring frequency, sampling and analysis procedures or methods, or statistical methods used at the facility necessary to meet the requirements of §264.99;	Any proposed changes to monitoring frequency, sampling and analysis procedures or statistical methods, if necessary to address provisions of the more comprehensive monitoring program.	
§264.98(g)(4)(iv)	For each hazardous constituent detected at the compliance point, a proposed concentration limit under §264.94(a)(1) or (2), or a notice of intent to seek an alternate concentration limit under §264.94(b); and	For hazardous constituents detected (as defined in §264.91(a)(1)), either background concentrations, maximum concentration limits or alternate concentration limits (ACLs) (or the intent to demonstrate ACLs) will be proposed.	
§264.98(g)(5)	Within 180 days, submit to the Secretary:	Within the specified time frame of 180 days, unless an alternative approach is more appropriate, submit to the Secretary the following:	
§264.98(g)(5)(i)	All data necessary to justify an alternate concentration limit sought under §264.94(b); and	Consideration of geologic and hydrologic conditions, waste inventory, receptor location(s), travel time, and degradation mechanisms may be included in the justification.	

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.98(g)(5)(ii)	An engineering feasibility plan for a corrective action program necessary to meet the requirement of §264.100, unless:	A feasibility plan for a groundwater corrective action program will be developed during the CMS/CMI process unless:	
§264.98(g)(5)(ii)(A)	All hazardous constituents identified under paragraph (g)(2) of this section are listed in Table 1 of §264.94 and their concentrations do not exceed the respective values given in that Table; or	Concentrations of hazardous constituents are not greater than MCLs; or	
§264.98(g)(5)(ii)(B)	The owner or operator has sought an alternate concentration limit under §264.94(b) for every hazardous constituent identified under paragraph (g)(2) of this section.	An ACL demonstration has been submitted for all constituents found.	
§264.98(g)(6)	If the owner/operator determines that, pursuant to paragraph (f) of this section, there is a statistically significant difference for chemical parameters or hazardous constituents specified pursuant to paragraph (a) of this section at any monitoring well at the compliance point, he/she demonstrate that a source other than a regulated unit caused the contamination or that the detection is an artifact caused by an error in sampling, analysis, or statistical evaluation or natural variation in the ground water. The owner/operator may make a demonstration under this paragraph in addition to, or in lieu of, submitting a permit modification application under paragraph (g)(4) of this section; however, owner/operator is not relieved of the requirement to submit a permit modification application within the time specified in paragraph (g)(4) of this section unless the demonstration made under this paragraph successfully shows that a source other than a regulated unit caused the increase, or that the increase resulted from error in sampling, analysis, or evaluation. In making a demonstration under this paragraph, the owner or operator must:	If contamination is detected but thought to have migrated from somewhere other than the TA-54 aggregate, was caused by sampling and analysis and/or statistical artifacts, or natural variations in groundwater, notification will be provided to the Secretary that a demonstration will be made, a demonstration report submitted, and any necessary modifications to the enforceable document requested to address appropriate changes to the monitoring program. Timeframes for submittals will be consistent with those established in §264.98(g)(6) and monitoring will continue.	
§264.98(g)(6)(i)	Notify the Secretary in writing within seven days of determining statistically significant evidence of contamination at the compliance point that he intends to make a demonstration under this paragraph;	See above.	
§264.98(g)(6)(ii)	Within 90 days, submit a report to the Secretary which demonstrates that a source other than a regulated unit caused the contamination or that the contamination resulted from error in sampling, analysis, or evaluation;	See above.	
§264.98(g)(6)(iii)	Within 90 days, submit to the Secretary an application for a permit modification to make any appropriate changes to the detection monitoring program facility; and	See above.	
§264.98(g)(6)(iv)	Continue to monitor in accordance with the detection monitoring program established under this section.	See above.	
§264.98(h)	If the owner/operator determines that the detection monitoring program no longer satisfies the requirements of this section, he/she must within 90 days submit an application for a permit modification to make any appropriate changes to the program.	A modification to the enforceable document will be requested if the monitoring prescribed in this program is no longer appropriate.	

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.99	An owner/operator required to establish a compliance monitoring program under this subpart must, at a minimum, discharge the following responsibilities:	Should hazardous constituents be "detected" (consistent with §264.91(a)(1)) resulting in the subsequent development of concentration limits consistent with §264.93 and §264.94, a more comprehensive monitoring program will be established that determines compliance with these limits. Concentrations will be measured at the aggregate boundary for the period of time equivalent to the remaining active life of the waste management area (including closure period).	
§264.99(a)	The owner/operator must monitor the ground water to determine whether regulated units are in compliance with the ground-water protection standard under §264.92. The Secretary will specify the ground-water protection standard in the facility permit, including:	See above.	
§264.99(a)(1)	A list of the hazardous constituents identified under §264.93;	See above.	
§264.99(a)(2)	Concentration limits under §264.94 for each of those hazardous constituents;	See above.	
§264.99(a)(3)	The compliance point under §264.95;	See above.	
§264.99(a)(4)	The compliance period under §264.96.	See above.	

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.99(b)	The owner/operator must install a ground-water monitoring system at the compliance point as specified under §264.95. The ground-water monitoring system must comply with §264.97(a)(2), (b), and (c).	Installation of a more comprehensive monitoring system will consider: location data, geology and hydrology, drilling methods, flow direction and velocity, potential contaminant behavior, and well completion and development details. Much of this information for TA-54 has been developed already in the Hydrogeologic Assessment of TA-54, Areas L and G, the Performance Assessment, and the RFI Reports for MDAs G, H and L and will continue through ongoing efforts of the Hydrogeologic Work Plan and the CMS/CMI process. The system will be capable of collecting groundwater samples from wells constructed and located in such a manner so as to be representative of the quality of groundwater passing beneath TA-54 at the aggregate boundary.	
§264.99(c)	The Secretary will specify the sampling procedures and statistical methods appropriate for the constituents and the facility, consistent with §264.97 (g) and (h).	Samples will be collected and analyzed for all relevant chemical parameters and hazardous constituents in such form as is appropriate for determination of statistical significance using appropriate sampling procedures and statistical methods.	
§264.99(c)(1)	The owner/operator must conduct a sampling program for each chemical parameter or hazardous constituent in accordance with §264.97(g).	See above.	
§264.99(c)(2)	The owner/operator must record ground-water analytical data as measured and in form necessary for the determination of statistical significance under §264.97(h) for the compliance period of the facility.	See above.	
§264.99(d)	The owner/operator must determine whether there is statistically significant evidence of increased contamination for any chemical parameter or hazardous constituent specified in the permit, pursuant to paragraph (a) of this section, at a frequency specified under paragraph (f) under this section.	Collect and analyze samples, evaluate data using appropriate statistical methodology and compare groundwater quality between the upgradient and downgradient wells at the aggregate boundary to determine whether statistically significant evidence of increased contamination exists within a reasonable timeframe.	

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.99(d)(1)	In determining whether statistically significant evidence of increased contamination exists, owner/operator must use the method(s) specified in the permit under §264.97(h). The methods(s) must compare data collected at the compliance point(s) to a concentration limit developed in accordance with §264.94.	See above.	
§264.99(d)(2)	The owner/operator must determine whether there is statistically significant evidence of increased contamination at each monitoring well at the compliance point within a reasonable time period after completion of sampling. The Secretary will specify that time period in the facility permit, after considering the complexity of the statistical test and the availability of analytical laboratories to perform the analysis of ground-water samples.	See above.	
§264.99(e)	The owner/operator must determine the ground-water flow rate and direction in the uppermost aquifer at least annually.	Groundwater flow rate and direction in the uppermost aquifer will be determined and reevaluated annually.	
§264.99(f)	The Secretary will specify the frequencies for collecting samples and conducting statistical tests to determine statistically significant evidence of increased contamination in accordance with §264.97(g). A sequence of at least four samples from each well (background and compliance wells) must be collected at least semi-annually during the compliance period of the facility.	An appropriate frequency for sample collection and statistical analysis will be proposed that will be capable of determining statistically significant evidence of increased contamination as described in §264.99(f).	
§264.99(g)	The owner/operator must analyze samples from all monitoring wells at the compliance point for all constituents contained in Appendix IX of part 264 at least annually to determine whether additional hazardous constituents are present in the uppermost aquifer and, if so, at what concentration, pursuant to procedures in §264.98(f). If the owner/operator finds Appendix IX constituents in the ground water that are not already identified in the permit as monitoring constituents, the owner/operator may resample within one month and repeat the Appendix IX analysis. If the second analysis confirms the presence of new constituents, the owner/operator must report the concentration of these additional constituents to the Secretary within seven days after the completion of the second analysis and add them to the monitoring list. If the owner/operator chooses not to resample, then he or she must report the concentrations of these additional constituents to the Secretary within seven days after completion of the initial analysis and add them to the monitoring list.	If annual sampling for all Appendix IX constituents indicates new constituents that are not already addressed statistically exceed background, and resampling within one month confirms this, the Secretary will be notified and the new constituents will be added to the monitoring list.	

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.99(h)	If the owner/operator determines pursuant to paragraph (d) of this section that any concentration limits under §264.94 are being exceeded at any monitoring well at the point of compliance, must:	If it has been determined that a statistically significant increase in contamination due to an exceedance of the previously established concentration limits has occurred at the downgradient aggregate boundary, the Secretary will be notified and a modification to the enforceable document requested to establish a corrective action program. It will include the actions necessary to correct the increase in contamination and a plan for a groundwater monitoring program to demonstrate the effectiveness of the action. An analysis of applicable remedial technologies will be performed through the CMS process, and the capabilities of the existing groundwater monitoring system will be assessed. Modifications/enhancements to the existing system will be proposed if necessary.	
§264.99(h)(1)	Notify the Secretary of finding in writing within seven days. The notification must indicate what concentration limits have been exceeded.	See above.	
§264.99(h)(2)	Submit to the Secretary an application for a permit modification to establish a corrective action program meeting the requirements of §264.100 within 180 days, or within 90 days if an engineering feasibility study has been previously submitted to the Secretary under §264.98(h)(5). The application must at a minimum include the following information:	See above.	
§264.99(h)(2)(i)	A detailed description of corrective actions that will achieve compliance with the ground-water protection standard specified in the permit under paragraph (a) of this section; and	See above.	
§264.99(h)(2)(ii)	A plan for a ground-water monitoring program that will demonstrate the effectiveness of the corrective action. Such a ground-water monitoring program may be based on a compliance monitoring program developed to meet the requirements of this section.	See above.	

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.99(i)	If the owner/operator determines, pursuant to paragraph (d) of this section, that the ground-water concentration limits under this section are being exceeded at any monitoring well at the point of compliance, may demonstrate that a source other than a regulated unit caused the contamination or that the detection is an artifact caused by an error in sampling, analysis, or statistical evaluation or natural variation in the ground water. In making a demonstration under this paragraph, the owner/operator must:	If contamination is detected but thought to have migrated from somewhere other than the TA-54 aggregate, was caused by sampling and analysis and/or statistical artifacts, or natural variations in groundwater, notification will be provided to the Secretary that a demonstration will be made, a demonstration report submitted, and any necessary modifications to the enforceable document requested to address appropriate changes to the monitoring program. Timeframes for submittals will be consistent with those established in §264.99(i) and monitoring will continue.	
§264.99(i)(1)	Notify the Secretary in writing within seven days that he intends to make a demonstration under this paragraph;	See above.	
§264.99(i)(2)	Within 90 days, submit a report to the Secretary which demonstrates that a source other than a regulated unit caused the standard to be exceeded or that the apparent noncompliance with the standards resulted from error in sampling, analysis, or evaluation;	See above.	
§264.99(i)(3)	Within 90 days, submit an application for a permit modification to the Secretary to make any appropriate changes to the compliance monitoring program at the facility; and	See above.	
§264.99(i)(4)	Continue to monitor in accord with the compliance monitoring program established under this section.	See above.	
§264.99(j)	If the owner/operator determines that the compliance monitoring program no longer satisfies the requirements of this section, must, within 90 days, submit an application for a permit modification to make any appropriate changes to the program.	A modification to the enforceable document will be requested if the monitoring prescribed in this program is no longer appropriate.	
§264.100	An owner/operator required to establish a corrective action program under this subpart must, at a minimum, discharge the following responsibilities:	Should hazardous constituent concentration levels be exceeded, a program that takes action to address the statistically significant increase identified will be established. Concentrations will be measured at the aggregate boundary for the period of time equivalent to the remaining active life of the waste management area (including closure period).	

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.100(a)	Owner/operator must take corrective action to ensure that regulated units are in compliance with the ground-water protection standard under §264.92. The Secretary will specify the ground-water protection standard in the facility permit, including:	See above.	
§264.100(a)(1)	A list of the hazardous constituents identified under §264.93;	See above.	
§264.100(a)(2)	Concentration limits under §264.94 for each of those hazardous constituents;	See above.	
§264.100(a)(3)	The compliance point under §264.95; and	See above.	
§264.100(a)(4)	The compliance period under §264.96.	See above.	
§264.100(b)	The owner/operator must implement a corrective action program that prevents hazardous constituents from exceeding their respective concentration limits at the compliance point by removing the hazardous waste constituents or treating them in place. The permit will specify the specific measures that will be taken.	A program will be implemented to prevent hazardous constituent concentration exceedances at the downgradient aggregate boundary that considers: contaminant distribution and mobility, additional characterization and/or monitoring needs (including vadose zone investigation), source term removal, and applicable remedial techniques.	
§264.100(c)	The owner/operator must begin corrective action within a reasonable time period after the ground-water protection standard is exceeded. The Secretary will specify that time period in the facility permit. If a facility permit includes a corrective action program in addition to a compliance monitoring program, the permit will specify when the corrective action will begin and such a requirement will operate in lieu of §264.99(i)(2).	Corrective action will begin within a reasonable time period after hazardous constituent concentration limits have been exceeded and will be conducted pursuant to the requirements established in the above-referenced corrective action program.	
§264.100(d)	In conjunction with a corrective action program, owner/operator must establish and implement a ground-water monitoring program to demonstrate the effectiveness of the corrective action program. Such a monitoring program may be based on the requirements for a compliance monitoring program under §264.99 and must be as effective as that program in determining compliance with the ground-water protection standard under §264.92 and in determining the success of a corrective action program under paragraph (e) of this section, where appropriate.	A groundwater monitoring program to demonstrate the effectiveness of the corrective action will be established and implemented. It will be based on considerations identified in the corrective action program and capable of detecting statistically significant exceedances in previously established hazardous constituent concentration limits. Additional monitoring wells may be installed and sampled if necessary.	

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.100(e)	In addition to the other requirements of this section, owner/operator must conduct a corrective action program to remove or treat in place any hazardous constituents under §264.93 that exceed concentration limits under §264.94 in groundwater:	The corrective action will also address hazardous constituents that exceed the concentration limits between the downgradient aggregate boundary and the downgradient property boundary, and off-site. Removal or in situ treatment of such constituents will occur in a reasonable time period, and, if off site, where necessary to protect human health and the environment. Corrective action can cease once limits are no longer exceeded.	
§264.100(e)(1)	Between the compliance point under §264.95 and the downgradient property boundary; and	See above.	
§264.100(e)(2)	Beyond the facility boundary, where necessary to protect human health and the environment, owner/operator demonstrates to the satisfaction of the Secretary that, despite the owner's or operator's best efforts, the owner or operator was unable to obtain the necessary permission to undertake such action. The owner/operator is not relieved of all responsibility to clean up a release that has migrated beyond the facility boundary where off-site access is denied. On-site measures to address such releases will be determined on a case-by-case basis.	See above.	
§264.100(e)(3)	Corrective action measures under this paragraph must be initiated and completed within a reasonable period of time considering the extent of contamination.	See above.	
§264.100(e)(4)	Corrective action measures under this paragraph may be terminated once the concentration of hazardous constituents under §264.93 is reduced to levels below their respective concentration limits under §264.94.	See above.	
§264.100(f)	The owner/operator must continue corrective action measures during the compliance period to the extent necessary to ensure that the ground-water protection standard is not exceeded. If the owner or operator is conducting corrective action at the end of the compliance period, he must continue that corrective action for as long as necessary to achieve compliance with the ground-water protection standard. Owner/operator may terminate corrective action measures taken beyond the period equal to the active life of the waste management area (including the closure period) if he can demonstrate, based on data from the ground-water monitoring program under paragraph (d) of this section, that the ground-water protection standard of §264.92 has not been exceeded for a period of three consecutive years.	Corrective action measures will continue until hazardous constituent concentration limits are no longer exceeded during the period equivalent to the remaining active life of the waste management area (including closure period). If corrective action is still occurring at the end of this period, it will continue until concentration limits are no longer exceeded for 3 consecutive years.	
§264.100(g)	The owner/operator must report in writing to the Secretary on the effectiveness of the corrective action program. The owner/operator must submit these reports semi-annually.	Semi-annual reports on the effectiveness of the corrective action will be provided to the Secretary.	

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.100(h)	The owner/operator determines that the corrective action program no longer satisfies the requirements of this section, he must, within 90 days, submit an application for a permit modification to make any appropriate changes to the program.	A modification to the enforceable document will be requested if it is determined that this program is no longer appropriate.	
§264.110(a)	Sections 264.111 through 264.115 apply to owners/operators of all hazardous waste management facilities.		Sections 1.0 and 2.0
§264.110(b)	Sections 264.116 through 264.120 apply to the owners/operators of:		Sections 3.0 and 4.0
§264.110(b)(1)	All hazardous waste disposal facilities;		Sections 3.0 and 4.0
§264.110(b)(2)	Waste piles and surface impoundments from which the owner/operator intends to remove wastes at closure . . .;		
§264.110(b)(3)	Tank systems that are required . . . to meet the requirements for landfills; and		
§264.110(b)(4)	Containment buildings that are required . . . To meet closure requirements for landfills.		
§264.110(c)	The Secretary may replace all or part of the requirements of this subpart (and the unit-specific standards referenced in §264.111(c) applying to a regulated unit), with alternative requirements set out in a permit or enforceable document, where the Secretary determines that:	The CMS report to be prepared for MDA L will provide a general description of how the proposed corrective measure will meet the closure and post-closure care requirements of 264.111 - 264.120. The CMI plan to also be prepared for MDA L will describe in detail how the selected corrective measure will meet closure/post-closure care requirements. Enforceable documents include Module VIII of LANL's Hazardous Waste Facility Permit and the CMS report and CMI plan for MDA L once they are approved .	Sections 1.0, 2.0, 3.0, and 4.0
§264.110(c)(1)	The regulated unit is situated among SWMUs or AOCs, a release has occurred, and both the regulated unit and one or more SWMUs or AOCs are likely to have contributed to the release; and	MDA L meets the criteria for alternative requirements because the existing land-based unit (Shafts 1, 13-17, and 19-34 and Impoundments B and D) is situated among SWMUs, a release has occurred, and the origin of the release is uncertain.	Sections 1.0 and 3.0, Attachment C
§264.110(c)(2)	It is not necessary to apply the closure requirements of this subpart (and those referenced herein) because the alternative requirements will protect human health and the environment and will satisfy the closure performance standard of §264.111(a) and (b).	The CMS report to be prepared for MDA L will provide a general description of how the proposed corrective measure will meet applicable closure and post-closure care requirements of §264.111 - 264.120; details will be provided in the CMI Plan.	Sections 1.0 and 3.0

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.111	Closure Performance Standard: Owner/operator must close the facility in a manner that:	For MDA L, the alternative requirements specified in the CMS report and ultimately detailed in the CMI plan will protect human health and the environment by meeting the intent of closure performance standards.	Section 1.2
§264.111(a)	Minimizes the need for further maintenance; and	For MDA L, the alternative requirements specified in the CMS report and ultimately detailed in the CMI plan will protect human health and the environment by meeting the intent of closure performance standards.	Sections 1.0, 2.0, and 3.0
§264.111(b)	Controls, minimizes or eliminates, to the extent necessary to protect human health and the environment, post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated run-off, or hazardous waste decomposition products to the ground or surface waters or to the atmosphere.	For MDA L, the alternative requirements specified in the CMS report and ultimately detailed in the CMI plan will protect human health and the environment by meeting the intent of closure performance standards.	Sections 1.0, 2.0, and 3.0
§264.111(c)	Complies with the closure requirements of this subpart, including . . . the requirements of . . . 264.310 . . .	See 264.310 regulatory requirement in this table.	
§264.112(a)(1)	Owner/operator of a hazardous waste management facility must have a written closure plan. . . . The plan must be submitted with the permit application . . . and approved by the Secretary as part of the permit issuance procedures . . . In accordance with 270.32 of this chapter, the approved closure plan will become a condition of any RCRA permit.	A closure plan for MDA L is included in this submittal. The closure of MDA L will utilize alternative requirements, which allows transfer of closure activities to the corrective action process. The CMS report to be prepared for MDA L will provide a general description of how the proposed corrective measure will meet the closure requirements of 264.111-264.115. The CMI plan to also be prepared for MDA L will describe in detail how the selected corrective measure will meet the closure requirements.	Sections 1.0 and 2.0
§264.112(a)(2)	The Secretary's approval of the plan must ensure that the approved closure plan is consistent with 264.111 through 264.115 and the applicable requirements of Subpart F of this Part, . . . 264.310 . . .. Until final closure is completed and certified in accordance with 264.115, a copy of the approved plan and all approved revisions must be furnished to the Secretary upon request, including requests by mail.	NA	Introduction
§264.112(b)	Closure plan must identify steps necessary to perform partial and/or final closure of the facility at any point during its active life. The closure plan must include, at least:	NA	Section 1.0
§264.112(b)(1)	A description of how each hazardous waste management unit at the facility will be closed in accordance with §264.111;	NA	Section 2.3

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.112(b)(2)	A description of how final closure of the facility will be conducted in accordance with §264.111. The description must identify the maximum extent of the operations which will be unclosed during the active life of the facility; and	NA	Section 1.1
§264.112(b)(3)	An estimate of the maximum inventory of hazardous wastes ever on-site over the active life of the facility and a detailed description of the methods to be used during partial closures and final closure, including, but not limited to, methods for removing, transporting, treating, storing, or disposing of all hazardous wastes, and identification of the type(s) of the off-site hazardous waste management units to be used, if applicable; and	NA	Sections 2.2 and 2.3
§264.112(b)(4)	A detailed description of the steps needed to remove or decontaminate all hazardous waste residues and contaminated containment system components, equipment, structures, and soils during partial and final closure, including, but not limited to, procedures for cleaning equipment and removing contaminated soils, methods for sampling and testing surrounding soils, and criteria for determining the extent of decontamination required to satisfy the closure performance standard; and	NA	Section 2.3
§264.112(b)(5)	A detailed description of other activities necessary during the closure period to ensure that all partial closures and final closure satisfy the closure performance standards, including, but not limited to, ground-water monitoring, leachate collection, and run-on and run-off control; and	NA	Section 2.3
§264.112(b)(6)	A schedule for closure of each hazardous waste management unit and for final closure of the facility. The schedule must include, at a minimum, the total time required to close each hazardous waste management unit and the time required for intervening closure activities which will allow tracking of the progress of partial and final closure. (For example, in the case of a landfill unit, estimates of the time required to treat or dispose of all hazardous waste inventory and of the time required to place a final cover must be included.)	NA	Section 1.4
§264.112(b)(7)	For facilities that use trust funds to establish financial assurance under §264.143 or §264.145 and that are expected to close prior to the expiration of the permit, an estimate of the expected year of final closure.	NA	Section 1.6

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.112(b)(8)	For facilities where the Secretary has applied alternative requirements at a regulated unit under §264.90(f), §264.110(c), and/or §264.140(d), either the alternative requirements applying to the regulated unit, or a reference to the enforceable document containing those alternative requirements.	The closure of MDA L will utilize alternative requirements, which allows transfer of closure activities to the corrective action process. The CMS report to be prepared for MDA L will provide a general description of how the proposed corrective measure will meet closure requirements. The CMI plan to also be prepared for MDA L will describe in detail how the selected corrective measure will meet closure requirements. Enforceable documents include Module VIII of LANL's Hazardous Waste Facility Permit and the CMS report and CMI plan for MDA L once they are approved.	Section 1.3
§264.112(c)	The owner/operator must submit a written notification of or request for a permit modification to authorize a change in operating plans, facility design, or the approved closure plan in accordance with the applicable procedures in Parts 124 and 270. The written notification or request must include a copy of the amended closure plan for review or approval by the Secretary.	NA	Section 1.5
§264.112(c)(1)	The owner/operator may submit a written notification or request to the Secretary for a permit modification to amend the closure plan at any time prior to the notification of partial or final closure of the facility.	NA	Section 1.5
§264.112(c)(2)	The owner/operator must submit a written notification of or request for a permit modification to authorize a change in the approved closure plan whenever:	NA	Section 1.5
§264.112(c)(2)(i)	Changes in operating plans or facility design affect the closure plan, or	NA	Section 1.5
§264.112(c)(2)(ii)	There is a change in the expected year of closure, if applicable, or	NA	Section 1.5
§264.112(c)(2)(iii)	In conducting partial or final closure activities, unexpected events require a modification of the approved closure plan.	NA	Section 1.5
§264.112(c)(2)(iv)	The owner/operator requests the Secretary to apply alternative requirements to a regulated unit under §264.90(f), §264.110(c), and/or § 264.140(d).	NA	Section 1.5

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.112(c)(3)	The owner/operator must submit a written request for a permit modification including a copy of the amended closure plan for approval at least 60 days prior to the proposed change in facility design or operation, or no later than 60 days after an unexpected event has occurred which has affected the closure plan. If an unexpected event occurs during the partial or final closure period, the owner or operator must request a permit modification no later than 30 days after the unexpected event. . . . . . the Secretary will approve, disapprove, or modify this amended plan in accordance with the procedures in parts 124 and 270. In accordance with §270.32 of this chapter, the approved closure plan will become a condition of any RCRA permit issued.	NA	Section 1.5
§264.112(c)(4)	The Secretary may request modifications to the plan under the conditions described in § 264.112(c)(2). The owner/operator must submit the modified plan within 60 days of the Secretary's request, or within 30 days if the change in facility conditions occurs during partial or final closure. Any modifications requested by the Secretary will be approved in accordance with the procedures in parts 124 and 270.	NA	Section 1.5
§264.112(d)	Notification of partial closure and final closure.		
§264.112(d)(1)	Owner/operator must notify the Secretary in writing at least 60 days prior to the date on which he expects to begin closure of a surface impoundment, waste pile, land treatment or landfill unit, or final closure of a facility with such a unit. . . .	NA	Section 1.4
§264.112(d)(2)	The date when it "expects to begin closure" must be either:		
§264.112(d)(2)(i)	No later than 30 days after the date on which any hazardous waste management unit receives the known final volume of hazardous wastes, or if there is a reasonable possibility that the hazardous waste management unit will receive additional hazardous wastes, no later than one year after the date on which the unit received the most recent volume of hazardous wastes. If the owner/operator of a hazardous waste management unit can demonstrate to the Secretary that the hazardous waste management unit or facility has the capacity to receive additional hazardous wastes and it has taken all steps to prevent threats to human health and the environment, including compliance with all applicable permit requirements, the Secretary may approve an extension to this one-year limit; or	NA	

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.112(d)(2)(ii)	For units meeting the requirements of §264.113(d), no later than 30 days after the date on which the hazardous waste management unit receives the known final volume of non-hazardous wastes, or if there is a reasonable possibility that the hazardous waste management unit will receive additional non-hazardous wastes, no later than one year after the date on which the unit received the most recent volume of non-hazardous wastes. If the owner/operator can demonstrate to the Secretary that the hazardous waste management unit has the capacity to receive additional non-hazardous wastes and it has taken, and will continue to take, all steps to prevent threats to human health and the environment, including compliance with all applicable permit requirements, the Secretary may approve an extension to this one-year limit.	NA	
§264.112(d)(3)	If the facility's permit is terminated, or if the facility is otherwise ordered, by judicial decree or final order under section 3008 of RCRA, to cease receiving hazardous wastes or to close, then the requirements of this paragraph do not apply. However, the owner/operator must close the facility in accordance with the deadlines established in §264.113.	NA	
§264.112(e)	Nothing in this section shall preclude the owner/operator from removing hazardous wastes and decontaminating or dismantling equipment in accordance with the approved partial or final closure plan at any time before or after notification of partial or final closure.	NA	NA
§264.113	Closure; Time allowed for closure		
§264.113(a)	Within 90 days after receiving the final volume of hazardous wastes, or the final volume of non-hazardous wastes if the owner/operator complies with all applicable requirements in paragraphs (d) and (e) of this section, at a hazardous waste management unit or facility, the owner/operator must treat, remove from the unit or facility, or dispose of on-site, all hazardous wastes in accordance with the approved closure plan. The Secretary may approve a longer period if the owner/operator complies with all applicable requirements for requesting a modification to the permit and demonstrates that:	NA	NA
§264.113(a)(1)(i)	The activities required to comply with this paragraph will, of necessity, take longer than 90 days to complete; or	NA	NA
§264.113(a)(1)(ii)(A)	The hazardous waste management unit or facility has the capacity to receive additional hazardous wastes, or has the capacity to receive non-hazardous wastes if the owner/operator complies with paragraphs (d) and (e) of this section; and	NA	NA
§264.113(a)(1)(ii)(B)	There is a reasonable likelihood that the owner/operator or another person will recommence operation of the hazardous waste management unit or the facility within one year; and	NA	NA
§264.113(a)(1)(ii)(C)	Closure of the hazardous waste management unit or facility would be incompatible with continued operation of the site; and	NA	NA

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.113(a)(2)	The owner/operator has taken and will continue to take all steps to prevent threats to human health and the environment, including compliance with all applicable permit requirements.	NA	NA
§264.113(b)	The owner/operator must complete partial and final closure activities in accordance with the approved closure plan and within 180 days after receiving the final volume of hazardous wastes, or the final volume of non-hazardous wastes if the owner or operator complies with all applicable requirements in paragraphs (d) and (e) of this section, at the hazardous waste management unit or facility. The Secretary may approve an extension to the closure period if the owner/operator complies with all applicable requirements for requesting a modification to the permit and demonstrates that:	NA	NA
§264.113(b)(1)(i)	The partial or final closure activities will, of necessity, take longer than 180 days to complete; or	NA	NA
§264.113(b)(1)(ii)(A)	The hazardous waste management unit or facility has the capacity to receive additional hazardous wastes, or has the capacity to receive non-hazardous wastes if the owner/operator complies with paragraphs (d) and (e) of this section; and	NA	NA
§264.113(b)(1)(ii)(B)	There is reasonable likelihood that the owner/operator or another person will recommence operation of the hazardous waste management unit or the facility within one year; and	NA	NA
§264.113(b)(1)(ii)(C)	Closure of the hazardous waste management unit or facility would be incompatible with continued operation of the site; and	NA	NA
§264.113(b)(2)	The owner/operator has taken and will continue to take all steps to prevent threats to human health and the environment from the unclosed but not operating hazardous waste management unit or facility, including compliance with all applicable permit requirements.	NA	NA
§264.113(c)	The demonstrations referred to in paragraphs (a)(1) and (b)(1) of this section must be made as follows:		
§264.113(c)(1)	The demonstrations in paragraph (a)(1) of this section must be made at least 30 days prior to the expiration of the 90-day period in paragraph (a) of this section; and	NA	NA
§264.113(c)(2)	The demonstration in paragraph (b)(1) of this section must be made at least 30 days prior to the expiration of the 180-day period in paragraph (b) of this section, unless the owner/operator is otherwise subject to the deadlines in paragraph (d) of this section.	NA	NA
§264.113(d)	The Secretary may allow an owner/operator to receive only non-hazardous wastes in a landfill, land treatment, or surface impoundment unit after the final receipt of hazardous wastes at that unit if:	NA	NA

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.113(d)(1)	The owner or operator requests a permit modification in compliance with all applicable requirements in parts 270 and 124 of this title and in the permit modification request demonstrates that:	NA	NA
§264.113(d)(1)(i)	The unit has the existing design capacity as indicated on the part A application to receive non-hazardous wastes; and	NA	NA
§264.113(d)(1)(ii)	There is a reasonable likelihood that the owner or operator or another person will receive non-hazardous wastes in the unit within one year after the final receipt of hazardous wastes; and	NA	NA
§264.113(d)(1)(iii)	The non-hazardous wastes will not be incompatible with any remaining wastes in the unit, or with the facility design and operating requirements of the unit or facility under this part; and	NA	NA
§264.113(d)(1)(iv)	Closure of the hazardous waste management unit would be incompatible with continued operation of the unit or facility; and	NA	NA
§264.113(d)(1)(v)	The owner or operator is operating and will continue to operate in compliance with all applicable permit requirements; and	NA	NA
§264.113(d)(2)	The request to modify the permit includes an amended waste analysis plan, ground-water monitoring and response program, human exposure assessment required under RCRA section 3019, and closure and post-closure plans, and updated cost estimates and demonstrations of financial assurance for closure and post-closure care as necessary and appropriate, to reflect any changes due to the presence of hazardous constituents in the non-hazardous wastes, and changes in closure activities, including the expected year of closure if applicable under § 264.112(b)(7), as a result of the receipt of non-hazardous wastes following the final receipt of hazardous wastes; and	NA	NA
§264.113(d)(3)	The request to modify the permit includes revisions, as necessary and appropriate, to affected conditions of the permit to account for the receipt of non-hazardous wastes following receipt of the final volume of hazardous wastes; and	NA	NA
§264.113(d)(4)	The request to modify the permit and the demonstrations referred to in paragraphs (d)(1) and (d)(2) of this section are submitted to the Secretary no later than 120 days prior to the date on which the owner/operator of the facility receives the known final volume of hazardous wastes at the unit, or no later than 90 days after the effective date of this rule in the state in which the unit is located, whichever is later.	NA	NA
§264.113(e)	Requirements for the owner/operator of a hazardous waste surface impoundment that is not in compliance with the liner and leachate collection system requirements.	NA	NA

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.114	During the partial and final closure periods, all contaminated equipment, structures and soils must be properly disposed of or decontaminated unless otherwise specified in §§ 264.197, 264.228, 264.258, 264.280 or § 264.310. By removing any hazardous wastes or hazardous constituents during partial and final closure, the owner/operator may become a generator of hazardous waste and must handle that waste in accordance with all applicable requirements of part 262 of this chapter.	NA	NA
§264.115	Within 60 days of completion of closure of each hazardous waste surface impoundment, waste pile, land treatment, and landfill unit, and within 60 days of the completion of final closure, the owner/operator must submit to the Secretary, by registered mail, a certification that the hazardous waste management unit or facility, as applicable, has been closed in accordance with the specifications in the approved closure plan. The certification must be signed by the owner or operator and by an independent registered professional engineer. Documentation supporting the independent registered professional engineer's certification must be furnished to the Secretary upon request until he releases the owner or operator from the financial assurance requirements for closure under §264.143(i).	NA	Section 1.7
§264.116	No later than the submission of the certification of closure of each hazardous waste disposal unit, the owner/operator must submit to the local zoning authority, or the authority with jurisdiction over local land use, and to the Secretary, a survey plat indicating the location and dimensions of landfills cells or other hazardous waste disposal units with respect to permanently surveyed benchmarks. This plat must be prepared and certified by a professional land surveyor. The plat filed with the local zoning authority, or the authority with jurisdiction over local land use, must contain a note, prominently displayed, which states the owner's or operator's obligation to restrict disturbance of the hazardous waste disposal unit in accordance with the applicable Subpart G regulations.	NA	Section 1.10
§264.117	Post-closure care and use of property		

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.117(a)(1)	Post-closure care for each hazardous waste management unit subject to the requirements of §§ 264.117 through 264.120 must begin after completion of closure of the unit and continue for 30 years after that date and must consist of at least the following:	A post-closure plan for MDA L is included in this submittal. The post-closure of MDA L will utilize alternative requirements, which allows transfer of closure activities to the corrective action process. The CMS report to be prepared for MDA L will provide a general description of how the proposed corrective measure will meet the post-closure care requirements of 264.117-120. The CMI plan to also be prepared for MDA L will describe in detail how the selected corrective measure will meet post-closure care requirements.	Section 3.2
§264.117(a)(1)(i)	Monitoring and reporting in accordance with the requirements of subparts F, K, L, M, N, and X of this part; and	The CMS report to be prepared for MDA L will provide a general description of how the proposed corrective measure will meet the post-closure care requirements of 264.117-120. The CMI plan to also be prepared for MDA L will describe in detail how the selected corrective measure will meet post-closure care requirements.	Sections 4.1 and 4.3
§264.117(a)(1)(ii)	Maintenance and monitoring of waste containment systems in accordance with the requirements of subparts F, K, L, M, N, and X of this part.	See above.	Sections 4.1 and 4.2
§264.117(a)(2)	Any time preceding partial closure of a hazardous waste management unit subject to post-closure care requirements or final closure, or any time during the post-closure period for a particular unit, the Secretary may, in accordance with the permit modification procedures in parts 124 and 270:		
§264.117(a)(2)(i)	Shorten the post-closure care period applicable to the hazardous waste management unit, or facility, if all disposal units have been closed, if he finds that the reduced period is sufficient to protect human health and the environment (e.g., leachate or ground-water monitoring results, characteristics of the hazardous wastes, application of advanced technology, or alternative disposal, treatment, or re-use techniques indicate that the hazardous waste management unit or facility is secure); or	NA	Section 3.2
§264.117(a)(2)(ii)	Extend the post-closure care period applicable to the hazardous waste management unit or facility if he finds that the extended period is necessary to protect human health and the environment (e.g., leachate or ground-water monitoring results indicate a potential for migration of hazardous wastes at levels which may be harmful to human health and the environment).	NA	Section 3.2

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.117(b)	The Secretary may require, at partial and final closure, continuation of any of the security requirements of §264.14 during part or all of the post-closure period when:	NA	Section 3.6
§264.117(b)(1)	Hazardous wastes may remain exposed after completion of partial or final closure; or	NA	Section 3.6
§264.117(b)(2)	Access by the public or domestic livestock may pose a hazard to human health.	NA	Section 3.6
§264.117(c)	Post-closure use of property on or in which hazardous wastes remain after partial or final closure must never be allowed to disturb the integrity of the final cover, liner(s), or any other components of the containment system, or the function of the facility's monitoring systems, unless the Secretary finds that the disturbance:	NA	Section 4.4
§264.117(c)(1)	Is necessary to the proposed use of the property, and will not increase the potential hazard to human health or the environment; or	NA	Section 4.4
§264.117(c)(2)	Is necessary to reduce a threat to human health or the environment.	NA	Section 4.4
§264.117(d)	All post-closure care activities must be in accordance with the provisions of the approved post-closure plan as specified in §264.118.	The CMS report to be prepared for MDA L will provide a general description of how the proposed corrective measure will meet the post-closure care requirements of 264.117-120. The CMI plan to also be prepared for MDA L will describe in detail how the selected corrective measure will meet post-closure care requirements.	Section 3.2
§264.118	Post-Closure Plan, Amendment of Plan		
§264.118(a)	The owner/operator of a hazardous waste disposal unit must have a written post-closure plan. . . . The plan must be submitted with the permit application, . . . , and approved by the Secretary as part of the permit issuance procedures under Part 124 of this chapter. In accordance with §270.32 of this chapter, the approved post-closure plan will become a condition of any RCRA permit issued.	A post-closure plan for MDA L is included in this submittal. The post-closure of MDA L will utilize alternative requirements, which allows transfer of closure activities to the corrective action process. The CMS report to be prepared for MDA L will provide a general description of how the proposed corrective measure will meet the post-closure care requirements of 264.117-120. The CMI plan to also be prepared for MDA L will describe in detail how the selected corrective measure will meet post-closure care requirements.	Introduction, Sections 3.0 and 4.0
§264.118(b)	For each hazardous waste management unit subject to the requirements of this section, the post-closure plan must identify the activities that will be carried on after closure of each disposal unit and the frequency of these activities, and include at least:	See above.	Section 4.0

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.118(b)(1)	A description of the planned monitoring activities and frequencies at which they will be performed to comply with subparts F, K, L, M, N, and X of this part during the post-closure care period; and	See above.	Section 4.1
§264.118(b)(2)	A description of the planned maintenance activities, and frequencies at which they will be performed, to ensure:	See above.	Section 4.2
§264.118(b)(2)(i)	The integrity of the cap and final cover or other containment systems in accordance with the requirements of subparts F, K, L, M, N, and X of this part; and	See above.	Section 4.2.1
§264.118(b)(2)(ii)	The function of the monitoring equipment in accordance with the requirements of subparts, F, K, L, M, N, and X of this part; and	See above.	Section 4.2.2
§264.118(b)(3)	The name, address, and phone number of the person or office to contact about the hazardous waste disposal unit or facility during the post-closure care period.		Section 4.5
§264.118(b)(4)	For facilities where the Secretary has applied alternative requirements at a regulated unit under §§264.90(f), 264.110(c), and/or §§264.140(d), either the alternative requirements that apply to the regulated unit, or a reference to the enforceable document containing those requirements.		Section 3.2
§264.118(c)	Until final closure of the facility, a copy of the approved post-closure plan must be furnished to the Secretary upon request, including request by mail. After final closure has been certified, the person or office specified in §264.188(b)(3) must keep the approved post-closure plan during the remainder of the post-closure period.		Introduction
§264.118(d)	The owner/operator must submit a written notification of or request for a permit modification to authorize a change in the approved post-closure plan in accordance with the applicable requirements in parts 124 and 270. The written notification or request must include a copy of the amended post-closure plan for review or approval by the Secretary.		Section 3.3
§264.118(d)(1)	The owner/operator may submit a written notification or request to the Secretary for a permit modification to amend the post-closure plan at any time during the active life of the facility or during the post-closure care period.		Section 3.3
§264.118(d)(2)	The owner/operator must submit a written notification of or request for a permit modification to authorize a change in the approved post-closure plan whenever:		Section 3.3
§264.118(d)(2)(i)	Changes in operating plans or facility design affect the approved post-closure plan, or		Section 3.3
§264.118(d)(2)(ii)	There is a change in the expected year of final closure, if applicable, or		Section 3.3
§264.118(d)(2)(iii)	Events which occur during the active life of the facility, including partial and final closures, affect the approved post-closure plan.		Section 3.3
§264.118(d)(2)(iv)	The owner/operator requests the Secretary to apply alternative requirements to a regulated unit under §264.90(f), §264.110(c), and/or §264.140(d).		Section 3.3

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.118(d)(3)	The owner/operator must submit a written request for a permit modification at least 60 days prior to the proposed change in facility design or operation, or no later than 60 days after an unexpected event has occurred which has affected the post-closure plan. An owner/operator of a surface impoundment or waste pile that intends to remove all hazardous waste at closure and is not otherwise required to submit a contingent post-closure plan under § 264.228(c)(1)(ii) and §264.258(c)(1)(ii) must submit a post-closure plan to the Secretary no later than 90 days after the date that the owner or operator or the Secretary determines that the hazardous waste management unit must be closed as a landfill, subject to the requirements of §264.310. The Secretary will approve, disapprove or modify this plan in accordance with the procedures in parts 124 and 270. In accordance with §270.32 of this chapter, the approved post-closure plan will become a permit condition.		Section 3.3
§264.118(d)(4)	The Secretary may request modifications to the plan under the conditions described in § 264.118(d)(2). The owner/operator must submit the modified plan no later than 60 days after the Secretary's request, or no later than 90 days if the unit is a surface impoundment or waste pile not previously required to prepare a contingent post-closure plan. Any modifications requested by the Secretary will be approved, disapproved, or modified in accordance with the procedures in parts 124 and 270.		Section 3.3
§264.119(a)	No later than 60 days after certification of closure of each hazardous waste disposal unit, the owner/operator must submit to the local zoning authority, or the authority with jurisdiction over local land use, and to the Secretary a record of the type, location, and quantity of hazardous wastes disposed of within each cell or other disposal unit of the facility. For hazardous wastes disposed of before January 12, 1981, the owner/operator must identify the type, location, and quantity of the hazardous wastes to the best of his knowledge and in accordance with any records it has kept.		Section 3.7
§264.119(b)	Within 60 days of certification of closure of the first hazardous waste disposal unit and within 60 days of certification of closure of the last hazardous waste disposal unit, the owner/operator must:		Section 3.7
§264.119(b)(1)	Record, in accordance with State law, a notation on the deed to the facility property -- or on some other instrument which is normally examined during title search -- that will in perpetuity notify any potential purchaser of the property that:		Section 3.7
§264.119(b)(1)(i)	The land has been used to manage hazardous wastes; and		Section 3.7
§264.119(b)(1)(ii)	Its use is restricted under 40 CFR subpart G regulations; and		Section 3.7

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.119(b)(1)(iii)	The survey plat and record of the type, location, and quantity of hazardous wastes disposed of within each cell or other hazardous waste disposal unit of the facility required by §264.116 and §264.119(a) have been filed with the local zoning authority or the authority with jurisdiction over local land use and with the Secretary; and		Section 3.7
§264.119(b)(2)	Submit a certification, signed by the owner/operator, that he has recorded the notation specified in paragraph (b)(1) of this section, including a copy of the document in which the notation has been placed, to the Secretary.		Section 3.7
§264.119(c)	If the owner/operator or any subsequent owner/operator of the land upon which a hazardous waste disposal unit is located wishes to remove hazardous wastes and hazardous waste residues, the liner, if any, or contaminated soils, it must request a modification to the post-closure permit in accordance with the applicable requirements in parts 124 and 270. The owner/operator must demonstrate that the removal of hazardous wastes will satisfy the criteria of §264.117(c). By removing hazardous waste, the owner/operator may become a generator of hazardous waste and must manage it in accordance with all applicable requirements of this chapter. If it is granted a permit modification or otherwise granted approval to conduct such removal activities, the owner/operator may request that the Secretary approve either:		Section 3.3
§264.119(c)(1)	The removal of the notation on the deed to the facility property or other instrument normally examined during title search; or		Section 3.3
§264.119(c)(2)	The addition of a notation to the deed or instrument indicating the removal of the hazardous waste.		Section 3.3
§264.120	No later than 60 days after completion of the established post-closure care period for each hazardous waste disposal unit, the owner/operator must submit to the Secretary, by registered mail, a certification that the post-closure care period for the hazardous waste disposal unit was performed in accordance with the specifications in the approved post-closure plan. The certification must be signed by the owner/operator and an independent registered professional engineer. Documentation supporting the independent registered professional engineer's certification must be furnished to the Secretary upon request until he releases the owner or operator from the financial assurance requirements for post-closure care under §264.145(i).		Section 3.5

Regulatory Citation(s)	Regulatory Requirements	Comments/Implementation of HSWA Activities	Location in Document
§264.310	Closure and post-closure care for landfills.	A post-closure plan for MDA L is included in this submittal. The post-closure of MDA L will utilize alternative requirements, which allows transfer of closure activities to the corrective action process. The CMS report to be prepared for MDA L will provide a general description of how the proposed corrective measure will meet the post-closure care requirements of 264.117-120. The CMI plan to also be prepared for MDA L will describe in detail how the selected corrective measure will meet post-closure care requirements.	
§264.310(a)	At final closure of the landfill or upon closure of any cell, the owner/operator must cover the landfill or cell with a final cover designed and constructed to:	See above.	Section 2.3
§264.310(a)(1)	Provide long-term minimization of migration of liquids through the closed landfill;	See above.	Section 2.3
§264.310(a)(2)	Function with minimum maintenance;		Section 2.3
§264.310(a)(3)	Promote drainage and minimize erosion or abrasion of the cover;		Section 2.3
§264.310(a)(4)	Accommodate settling and subsidence so that the cover's integrity is maintained; and		Section 2.3
§264.310(a)(5)	Have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present.	See above.	Section 2.3
§264.310(b)	After final closure, the owner/operator must comply with all post-closure requirements contained in §264.117 through §264.120, including maintenance and monitoring throughout the post-closure care period (specified in the permit under §264.117). The owner/operator must:	See above.	Section 4.0
§264.310(b)(1)	Maintain the integrity and effectiveness of the final cover, including making repairs to the cap as necessary to correct the effects of settling, subsidence, erosion, or other events;	See above.	Sections 3.2 and 4.2.1
§264.310(b)(2)	Continue to operate the leachate collection and removal system until leachate is no longer detected;	See above.	Section 4.2.2
§264.310(b)(3)	Maintain and monitor the leak detection system in accordance with § 264.301(c)(3)(iv) and (4) and §264.303(c), and comply with all other applicable leak detection system requirements of this part;	See above.	Sections 4.1 and 4.2
§264.310(b)(4)	Maintain and monitor the ground-water monitoring system and comply with all other applicable requirements of subpart F of this part;	See above.	Sections 4.1 and 4.2
§264.310(b)(5)	Prevent run-on and run-off from eroding or otherwise damaging the final cover; and	See above.	Sections 3.2 and 4.2
§264.310(b)(6)	Protect and maintain surveyed benchmarks used in complying with §264.309.	See above.	Section 4.2.2

ATTACHMENT B

GEOLOGY, HYDROLOGY, AND GROUNDWATER CHARACTERIZATION AT TECHNICAL AREA 54, AREA L

GEOLOGY, HYDROLOGY, AND GROUNDWATER CHARACTERIZATION AT TECHNICAL AREA 54, AREA L

April 2002

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LIST OF ABBREVIATIONS/ACRONYMS

bgs	below ground surface
CA	composite analysis
cm	centimeter(s)
cm^2	square centimeters
cm/hr	centimeters per hour
cm/sec	centimeters per second
cm/yr	centimeters per year
DQO	Data Quality Objective
EP	Extraction Procedure
ER	Environmental Restoration
FEHM	Finite Element Heat and Mass
ft	feet (foot)
ft/d	feet per day
ft/yr	feet per year
FY	Fiscal Year
HE	high explosives
in.	inch(es)
in./yr	inches per year
LANL	Los Alamos National Laboratory
m	meter(s)
MCL	maximum concentration level
MDA	material disposal area
µg/L	micrograms per liter
mg/L	milligrams per liter

LIST OF ABBREVIATIONS/ACRONYMS
(Continued)

mm	millimeter(s)
mm/yr	millimeters per year
NMED	New Mexico Environment Department
PA	performance assessment
pCi/L	picocuries per liter
ppm	parts per million
R	regional aquifer
RDX	Hexahydro-1,3,5-trinitro-1,3,5-triazine
SW-846	EPA's "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods"
TA	technical area
VOC	volatile organic compound

GEOLOGY, HYDROLOGY, AND GROUNDWATER CHARACTERIZATION AT TECHNICAL AREA 54, AREA L

1.0 GEOLOGY AND HYDROLOGY AT TECHNICAL AREA 54, AREA L

Numerous investigations of the geology and hydrology at Technical Area (TA) 54 have been conducted at Los Alamos National Laboratory (LANL). The following sections describe the extensive studies conducted at TA-54 in the past, and present information on future characterization activities and hydrologic modeling. LANL's TA-54, Area L, is located on Mesita del Buey, an east-west trending mesa bordered on the north by Cañada del Buey and on the south by Pajarito Canyon.

1.1 Geology and Stratigraphy

The following information on the geology and stratigraphy at TA-54 was obtained from borehole core logs. Unit 2 of the Tshirege Member of the Bandelier Tuff is at the surface of Mesita del Buey. This moderately welded ash-flow tuff forms nearly vertical cliffs on the sides of mesas, and at Area L is approximately 45 to 50 feet (ft) thick. A series of thin, discontinuous surge beds mark the base of Unit 2. Tshirege Member Unit 1v underlies Unit 2. This vapor-phase altered cooling unit forms sloping outcrops, and is further divided into Units 1vu and 1vc. Unit 1vu is a poorly welded ash-flow tuff. At TA-54, the thickness of Unit 1vu ranges from about 90 ft near Material Disposal Area (MDA) H to about 46 ft near MDA G. Unit 1vc is a moderately to poorly welded ash-flow tuff and ranges from 49 ft thick at the western end of Mesita del Buey to 23-26 ft thick at the eastern end. At the base of Unit 1v is Tshirege Member Unit 1g, which is a vitric, pumiceous, nonwelded ash-flow tuff. This unit is about 150 ft thick at MDA H, and thins to about 49 ft thick at the eastern end of MDA G. A distinctive pumice-poor surge deposit forms the base of Unit 1g. Beneath Unit 1g is the Tsankawi Pumice Bed, which at Area L is a thin (about 3-ft-thick) bed of gravel-sized pumice. It is the basal air fall deposit of the Tshirege Member. The Cerro Toledo interval is stratigraphically beneath the Tsankawi Pumice Bed; it separates the Tshirege and Otowi Members of the Bandelier Tuff, and averages about 40 ft thick at Area L. The Otowi Member is a massive, nonwelded, pumice-rich ash-flow tuff. At Area L, it ranges from about 64 to 109 ft thick. At the base of the Otowi Member is the Guaje Pumice Bed. At Area L, this basal air fall deposit averages about 9 ft thick. Beneath the Guaje Pumice Bed are the Cerros del Rio basalts. It is inferred that these basalts exist beneath Mesita del Buey, based on borehole data at Area L, and the thickness beneath TA-54 was extrapolated to be between 262 and 492 ft. Although the depth to and thickness of the Puye Formation beneath the Cerros del Rio basalts at TA-54 were not determined as a result of borehole investigations, they were encountered beneath the basalts at a water-supply well in Pajarito Canyon, approximately one mile west of Mesita del Buey.

1.2 Soils

Mesa-top soils at TA-54 form from weathering of the Tshirege Member of the Bandelier Tuff and from aeolian deposits. These soils are primarily Hackroy sandy loams that typically range from a brown sandy loam in the top 8 centimeters (cm) to a reddish brown from 8 to 30 cm in depth. Where present, the native soils are thickest near the mesa's center and thinner near the edges. Generally, the mesa surface soils are thin and poorly developed. Near the surface, their texture is sandy; beneath the surface, they exhibit a more clay-like texture. Permeability rates range from 5 to 15 cm per hour (cm/hr) in the top layers down to 0.15 to 0.50 cm/hr in the lower layers. In addition to Hackroy sandy loams, soil types at TA-54 include Nyjack loam, Totavi gravelly loamy sand, Hackroy-Rock outcrop complex, Servilleta loam, Penistaja sandy loam, and Prieta silt loam (Nyhan et al., 1978).

1.3 Surface Water

Mesita del Buey is one of the drier mesas at LANL and there are no streams on the mesa. Surface water flows only as storm water and snowmelt runoff. South of Mesita del Buey, Pajarito Canyon is one of the wetter canyons at LANL; north of Mesita del Buey, Cañada del Buey is one of the driest. Streams in these canyons are intermittent.

1.4 Perched Water

To meet a May 7, 1985 Compliance Order/Schedule, test wells were installed in the canyons north and south of TA-54 to determine if perched water existed within canyon alluvium, to determine if perched water extended beneath Mesita del Buey, and to sample/monitor perched water, if present (IT Corporation, 1987). In 1985, three test wells were installed in a tributary to Cañada del Buey; they include CDBO-1 (to a depth of 15 ft), CDBO-2 (30 ft), and CDBO-3 (20 ft); test well CDBO-4 (to a depth of 21 ft) was installed further to the east in Cañada del Buey. All 4 wells were dry; however, they were completed as observation wells to monitor the alluvium for possible water in the future (Purtymun, 1995). The 1985 investigation indicated that the alluvium in Cañada del Buey contained no perched water (Devaurs and Purtymun, 1985).

Three test wells were also installed in Pajarito Canyon in 1985; they are PCO-1, PCO-2, and PCO-3 (Purtymun, 1995). These 3 wells are sampled for radionuclides, metals, general inorganics, and organics. Sampling results are compiled annually in environmental surveillance reports and submitted to the New Mexico Environment Department (NMED). To ensure that the alluvial aquifer in Pajarito Canyon did not extend northward beneath Mesita del Buey, 4 test holes were drilled in the canyon floor north of the intermittent stream channel in 1985 (Devaurs and Purtymun, 1985). These 4 test holes, designated PCM-1, PCM-2, PCM-3, and PCM-4, were dry. They were completed for use as moisture-access holes (Purtymun, 1995). It was concluded that perched water in Pajarito Canyon is confined to the alluvium in the stream channel and does not extend to the flank of the canyon (Purtymun, 1995). As stated in the "Hydrogeologic Workplan" (LANL, 1998), no perched groundwater has been identified beneath Mesita del Buey.

In addition to the seven test holes drilled in Pajarito Canyon in 1985, two test holes were drilled in 1950 as part of a water-supply study (Griggs, 1964; Purtymun, 1975). These holes are identified as T-5 and T-6; they were drilled to depths of 263 ft and 300 ft, respectively, and completely penetrated the Bandelier Tuff beneath the floor of Pajarito Canyon. No water was encountered. The same holes were dry when measured in 1985 (Devaurs and Purtymun, 1985).

Two mesa-top test holes at Area G were drilled to depths that were equivalent to up to 40 ft beneath the base of the alluvium in Pajarito Canyon, and three mesa-top test holes at Area L were drilled to depths that were equivalent to up to 48 ft beneath the Pajarito Canyon allluvium. None of these test holes encountered perched water (IT Corporation, 1987).

Five observation wells were installed in Cañada del Buey, mostly up-gradient from Area L, as part of a 1992 investigation for a proposed sanitary wastewater treatment plant. These wells, installed to study the effect of effluent release on the environment in the canyon, are CDBO-5, CDBO-6, CDBO-7, CDBO-8, and CDBO-9. In addition, two moisture-access holes (CDBM-1 and CDBM-2) were drilled north of Area L in 1992. Perched water was encountered in the canyon alluvium at wells CDBO-6 and CDBO-7. It was determined that the perched water at these locations is likely only the result of operational discharges from well PM-4 (Purtymun, 1995).

1.5 Vadose Zone

A summary of the hydrogeology of Areas G and L and additional data and discussions relevant to the potential for migration of hazardous waste from MDAs G and L is presented in the "Hydrogeologic Assessment of Technical Area 54, Areas G and L, Los Alamos National Laboratory" (IT Corporation, 1987). The assessment was prepared in response to a May 7, 1985 Compliance Order/Schedule issued to LANL by the New Mexico Environmental Improvement Division. The Order mandated specific tests and investigations be performed at Areas G and L to obtain information on the hydrologic characteristics of the waste disposal areas relevant to the potential for hazardous waste or hazardous constituent migration into the groundwater. The discussion that follows is extracted from the assessment (IT Corporation, 1987) prepared using numerous reports by Bendix Field Engineering Corporation and LANL on the results of individual tests or groups of tests.

In late 1985 and 1986, an investigation was initiated to fulfill the testing requirements of the Order, which included characterizing the vadose zone in and around MDA L. Eighteen (18) boreholes were drilled to a depth ranging from 60 to 145 ft into the Bandelier Tuff from the top of Mesita del Buey. Nearly 1,700 ft of core was obtained from 16 of these holes. An additional 60-ft deep borehole was drilled near a surface impoundment at Area L. Hydrologic testing and geophysical logging were performed in the boreholes, and selected core samples were analyzed for numerous parameters. A number of boreholes were completed for pore-gas sampling, neutron moisture monitoring, and psychrometer installation. As discussed in Section 1.4, holes were also drilled in Cañada del Buey and Pajarito Canyon, adjacent to Mesita del Buey, to investigate possible alluvial aquifers.

To provide a quantitative analysis of moisture movement in the Bandelier Tuff, vadose zone characterization studies were conducted at Areas G and L. The quantitative analyses would help to determine the likelihood of contaminant migration from Areas G and L through the vadose zone and into groundwater beneath the sites. To quantify moisture movement in the tuff, a two-tiered approach was utilized. First, hydrologic characteristics of the tuff and hydraulic head were measured to calculate seepage velocity and rates of moisture flux. Second, the moisture content of the tuff was measured after precipitation events to determine changes in moisture content with depth.

Hydrologic testing was performed in the boreholes and on borehole core samples in the laboratory to allow calculation of seepage velocity and moisture flux rates in the tuff. Intrinsic permeability was measured in boreholes through air injection and vacuum tests. Laboratory tests included the Dynamic Method to measure gas-water relative permeability, and gas injection with correction for slippage. Intrinsic permeability ranged from about 10^{-8} to 10^{-9} square centimeters (cm^2) for fractured and unfractured intervals. Similar results were obtained from a water injection test performed to verify the results of the air injection tests. Vacuum tests performed in the same boreholes yielded slightly lower permeability values; however, they also averaged in the 10^{-8} to 10^{-9} cm^2 range. In the laboratory tests, intrinsic permeability yielded values in the low 10^{-9} cm^2 range. Because discontinuities that occur in the rock intersected by the borehole are not typically present in laboratory-tested cores, lower intrinsic permeability values are expected for laboratory tests.

Laboratory measurements were conducted for gravimetric moisture content, soil-moisture characteristic curves, and unsaturated hydraulic conductivity of borehole tuff samples. The gravimetric moisture content generally ranged from 2 to 4%, with isolated intervals that ranged up to 10 to 28%. Soil moisture characteristic curves were determined for 20 tuff samples, and moisture content was determined for capillary pressures in the range of -0.03 to -0.34 bar. Attempts to measure moisture contents at lower capillary pressures were not successful because samples disaggregated. Hence, moisture characteristic curves could only be determined for volumetric moisture contents above 22%, which is considerably higher than the values observed from testing core samples of field measurements. From the characteristic curve data, it was concluded that moisture retention values of the tuff are extremely high, and ranged up to 80% (60% volumetric moisture). The moisture retention value of 80% indicates that no liquid transport can occur at moisture content below this value. Because all of the moisture content measurements for the tuff were significantly below 80%, it was concluded that capillary transport of liquids does not contribute to moisture movement and vapor transport is clearly the major mechanism of water transport. Unsaturated flow is not likely to be a major factor in liquid transport at these moisture content levels.

This conclusion was supported by actual measurements of moisture content in the tuff at depth. Neutron logging was performed every two weeks at one borehole each in Areas G and L for approximately eight months. In addition, neutron logging was performed daily for a period after three major precipitation events. Moisture profiles measured with neutron logging showed the upper 10 to 20 ft of tuff to be affected by precipitation events and subject to seasonal fluctuations. However, below 20 ft, the moisture content is extremely low and in the range of the gravimetric moisture values (2 to 4%).

The 1986 moisture profiles were consistent with moisture measurements conducted previously on the Bandelier Tuff. Neutron-moisture data of the tuff at various locations at LANL were measured between 1960 and 1980 (Abeele et al., 1981). Those data showed that moisture conditions ranged from 10 to 40% by volume in the upper 10 to 15 ft of tuff, and that below 15 ft, moisture rarely exceeded 5 to 10%. In addition, those data showed that in the uppermost four meters of disturbed areas at Area G, significant seasonal fluctuations in moisture content exist. Those findings are consistent with the 1986 data. Overall, the moisture data reported in Abeele et al. (1981) and in the hydrogeological assessment (IT Corporation, 1987) are consistent and show the following:

- Throughout the area, moisture content of the tuff is low (typically between 2 to 5% with intervals ranging up to 10 to 28%)
- In the upper 10 to 20 ft of tuff, seasonal variation of moisture content occurs; however, below ~20 ft, seasonal variations are not measurable
- Precipitation from monitored autumn storms does not infiltrate below ~10 ft.

From these studies, the following conclusions were made: 1) the tuff is not saturated and is in fact very dry; and 2) moisture from precipitation does not infiltrate to a significant depth. Therefore, meteoric water infiltration is not a viable process for transport of hazardous waste or hazardous constituents through the vadose zone at Areas G and L.

Thermocouple psychrometers were installed at numerous depths in one borehole each in Areas G and L to measure capillary potential. The psychrometer data were highly variable, but indicated that soil moisture tensions ranged from 1 to 15 bars. Moisture flux calculations were performed using measured hydraulic conductivity values for the tuff and hydraulic head data from the psychrometers to determine maximum rates of moisture movement in the tuff. A maximum downward flux (using average measured hydraulic conductivity) of 0.254 ft per year (ft/yr) and a maximum upward flux of 0.198 ft/yr were calculated using average measured hydraulic conductivity for Area L. Because only hydraulic conductivity values at higher percentages of saturation than those actually observed in the field were available, the calculated flux rates very likely overestimate the moisture flux values. Because hydraulic conductivity in the vadose zone typically increases with increases in percent saturation, the measured hydraulic conductivity values are greater than the actual field conditions. If calculated (rather than measured) hydraulic conductivity values are used, lower flux rate values (by approximately an order of magnitude) are predicted. The moisture flux values, though highly conservative, show that very long periods of time would be required for water and contaminants to move by unsaturated flow from the MDAs to the groundwater. In summary, there is no evidence to suggest that saturation of the tuff and subsequent transport of contaminants by saturated flow is likely.

Based on the data collected in the 1985/1986 investigation, the following conclusions were made regarding the hydrologic characterization of the vadose zone and potential aqueous phase migration of contaminants:

- The Bandelier Tuff is characterized by very low moisture content (typically in the range of 2 to 5%). This value is well below the porosity; thus, moisture movement by unsaturated flow processes predominate over saturated flow.
- The tuff has high moisture retention properties and is very porous, averaging 50% porosity.
- Intrinsic permeability tests (both field and laboratory) indicate average permeability of the tuff to be 10^{-8} to 10^{-9} cm^2.
- Permeability tests conducted in the field do not indicate increased permeability in zones adjacent to fractures in boreholes. Aperture, trace, and degree of fracture filling is variable, however, and permeability along fractures may vary significantly.
- The tuff's unsaturated hydraulic conductivity was determined to be approximately 10^{-8} centimeters per second at approximately 20 to 40% moisture content, determined by measured effective permeability and using van Genuchten's model. Actual moisture conditions and unsaturated hydraulic conductivity are likely lower than these values.
- Due to the low moisture content in the tuff and the low degree of consolidation within the sampled tuff, soil-characteristic curves for intact cores could not be determined for the range of moisture/tension conditions present in the field.
- Soil water tension measured by thermocouple psychrometers range from 1 to 15 bars. Monthly averages typically ranged from 2 to 7 bars.
- Seasonal variation of moisture occurs in the upper 10 to 15 ft of the vadose zone, as indicated by neutron measurements of vadose zone moisture. Below 15 ft, moisture content does not appear to change with time. Neutron measurements of moisture following precipitation events indicate the maximum depth of wetting to be approximately 10 ft. At a

depth of 22 ft, no influence of precipitation on moisture content was observed; moisture is assumed to be returned to the surface by evapotranspiration.

- The maximum flux rate using average measured hydraulic conductivity at Area L ranged from a downward rate of 0.254 ft/yr to a maximum upward rate of 0.198 ft/yr. These moisture flux values show that very long periods of time would be required for water and contaminants to move by unsaturated flow.

Chemical characterization of the Bandelier Tuff vadose zone was also conducted at Areas G and L to fulfill the requirements of the May 7, 1985 Compliance Order. The data were obtained from core sample analysis and pore-gas sampling and analysis. A total of 70 core samples were collected from seven boreholes at Areas G and L (Devaurs, 1985). In addition, three test hole locations adjacent to Impoundment B at Area L were selected for coring, together with one shallow test hole location selected within the impoundment. All cores except two had Extraction Procedure (EP) Toxic metals below detection limit concentrations, which are well below EP Toxicity concentrations. An Area L core sample, collected from the 10- to 20-ft depth near Impoundment B, slightly exceeded the EP Toxic regulatory limit for chromium. Chromium and cadmium concentrations above EP Toxic levels were also present in the 8 to 29-inch depth samples from Impoundment B. No EP Toxic metals were detected in any boreholes at Area L below a depth of 30 ft. It was noted that the lower detection limit for most of the volatile organic compounds (VOC) was in the parts per million (ppm) range, which did not allow detection for possible trace concentrations present. At Area L, VOCs were detected in core samples from various depths in five of the boreholes from which samples were collected. The detected compounds included a suite of common solvents and ketones (e.g., methylene chloride, acetone, tetrahydrofuran, and methyl ethyl ketone). The concentrations of these compounds ranged from parts per billion to ppm at depths up to 100 ft, the approximate depths of the holes.

Twenty-three sampling ports were installed in seven boreholes to allow collection of pore-gas at various depths (Devaurs and Bell, 1986). The pore-gas samples were collected by pumping air from the sampling port through charcoal adsorption tubes. The volatile organics were then extracted from the charcoal for analysis. The analytical results indicated that VOCs in the pore gas were present in ppm concentrations at depths up to approximately 100 ft, the approximate depths of the holes.

The core analyses and the pore-gas data suggested that volatile organic constituents from the wastes disposed of at MDA L have migrated into the tuff. It was determined that, based on the vadose zone characterization studies, vapor diffusion is the predominant mechanism for migration.

As noted in the hydrogeologic assessment prepared in 1987 (IT Corporation), the regional aquifer was encountered at a depth of approximately 875 ft just west of Areas G and L. Calculations using the hydraulic gradient of the Tesuque Formation (0.015) predicted depths to the regional aquifer beneath Area L as 950 ft.

Water samples collected from the wells in Pajarito Canyon (described in Section 1.4) were analyzed for VOCs, selected metals, and radionuclides. No VOCs were detected in these samples, and metal and radionuclide concentrations were found to be below drinking water standards. It was concluded that there appears to be no discernable effect on water quality in Pajarito Canyon from disposal operations at Area L.

Based on the hydrogeologic investigations performed at Mesita del Buey in 1985 and 1986 and on other previous work, several specific conclusions were reached regarding the characteristics of Areas G and L and the potential for contaminant migration from the waste disposal units there. These conclusions are:

- The stratigraphy of the Bandelier Tuff at Areas G and L is similar to that throughout the western portion of the Pajarito Plateau.
- Vertical and near-vertical cooling fractures are common in the tuff at Mesita del Buey.
- No major fault zones are known to exist at or near Areas G and L that could serve as conduits from the shallow subsurface to the regional groundwater.
- Together, the very low moisture content in the tuff, the empirical determination that moisture from precipitation does not infiltrate below a depth of 10 to 22 ft, and the very low calculated flux rates all suggest that aqueous transport of contaminants is not a viable mechanism for contaminant migration at Areas G and L.
- Based on the results of core and pore-gas analyses, volatile organic constituents have migrated (predominantly in the vapor phase) from the MDAs into the tuff.
- At Area L, elevated levels of metals were detected in samples from only two locations (within and adjacent to Impoundment B) at shallow depths (30 ft or less).
- Based on the presence of volatile organic vapors at depths of up to 100 ft, core and pore-gas data support vapor phase migration as the dominant transport mechanism at TA-54.

- No perched water bodies that could be connected hydraulically to the regional aquifer were detected beneath Areas G and L.

- No perched water was detected in Cañada del Buey. Perched water in Pajarito Canyon is confined to the alluvium within the canyon and does not extend vertically or horizontally into the Bandelier Tuff that forms Mesita del Buey.

- There is no evidence of liquid migration from Areas G and L into the alluvial perched water in Pajarito Canyon.

Hydrogeologic conditions at TA-54 were also investigated as part of the performance assessment (PA) and composite analysis (CA) for the low-level radioactive waste disposal facility at MDA G, which is only 0.5 miles east of Area L. The following discussion summarizes the hydrogeologic conditions reported in the "Performance Assessment and Composite Analysis for Los Alamos National Laboratory Material Disposal Area G" (LANL, 1997), which presents the most recent vadose zone information available. This information is indicative of the condition at Area L because of its close proximity to Area G. Overall, the report was generally in agreement with previous investigations and stated that when combined with the semiarid climate, the Bandelier Tuff is typically very dry and that the volumetric moisture content averages about 5%, although it is quite variable depending on location. Moisture variations due to near-surface climatic influences, influences of fractures, and textural differences between tuff units and interbeds are suggested by routine moisture measurements taken from boreholes at numerous locations around MDA G. Evaporation and transpiration from the mesa's surface (i.e., evapotranspiration) remove much of the moisture from precipitation absorbed by the tuff. This investigation also found that evapotranspiration is effective to depths of 1 to 2 meters (m) (3 to 7 ft), where plant roots are abundant. In addition to the near-surface drying, evaporation appears to occur along the sides of the mesa and in fractures and surge beds, which are layers within the mesa that appear to allow air flow. The relative absence of moisture nearly eliminates the possibility that contaminants will be transported through the tuff to the regional aquifer (LANL, 1997).

The PA/CA was supported by a fairly complete set of data and observations to characterize the uppermost 60 m (200 ft) of the Tshirege Member of the Bandelier Tuff beneath MDA G. Unit 2 of the Bandelier Tuff is the caprock that forms the top of Mesita del Buey. This unit is extensively fractured as a result of contraction upon post-depositional cooling. The cooling-joint fractures, which are mostly vertical, generally dissipate at the bottom of Unit 2, which at Area G is about 12 m (39 ft) thick. Mean spacing between fractures is about 1 m (3.3 ft), and fracture widths range from less than 1 millimeter (mm) to 13 mm (<0.03 to 0.51 inches [in.]) with a median of 3 mm (0.12 in.). Typically, fractures are filled with smectite clays to a depth of about 3 m (10 ft). Smectite clays (e.g., montmorillonite) are known for their tendency to swell when water is present and for their ability to strongly bind certain elements. Both of these properties have implications for transport of contaminants in fractures (LANL, 1997). Typically, fractures in Unit 2 do not extend into Unit 1vu. Only the more prominent cooling fractures originating in Unit 2 continue into the more welded upper section of Unit 1 vu; however, they die out in the less consolidated lower section.

The degree of welding and devitrification are two properties of the tuff that influence fluid flow. In welded, devitrified tuff, there are several competing effects that determine moisture content and fluid flux. Welded tuffs tend to be more fractured than non-welded tuffs. Although water moves slowly through an unsaturated tuff matrix, it can move relatively rapidly through fractures only if nearly saturated conditions exist (LANL, 1997). As indicated by modeling studies, moisture is absorbed into the matrix when fractures disappear at contacts between stratigraphic subunits, when fracture fills are encountered, or when coatings are interrupted. Because fractures are open to the passage of both air and water, they can have both wetting and drying effects, depending on the relative abundance of water in the fractures and matrix (LANL, 1997).

As a rule, the Tshirege Member of the Bandelier Tuff is very dry and does not readily transmit moisture. Most of the pore spaces in the tuff are small enough to be of capillary size and have a strong tendency to hold water against gravity by surface-tension forces. Moisture content is generally more variable near the top of the mesa than in the central portions as a result of variations in temperature, humidity, and evapotranspiration. Vegetation is very effective at removing moisture near the surface by transpiration. During the summer rainy season when rainfall is highest, near-surface moisture content is variable due to the effects of higher rates of evaporation and of transpiration by vegetation, which flourishes during this time (LANL, 1997).

For the PA/CA, a great deal of information was needed to first conceptualize and then model moisture flow and contaminant transport in the vadose zone. The necessary information included the basic properties of the tuff (e.g., porosity, density, fracture patterns, and mineralogy); these can be measured accurately. It also included the complicated relationships describing how fluids move through the tuff (e.g., moisture content, matric suction, and hydraulic conductivity), which are more difficult to establish with a great deal of certainty in a matrix with very low moisture content. A number of field, laboratory, and analytical studies were performed to support the development of conceptual and mathematical models for flow and transport in the vadose zone (LANL, 1997).

Characteristic curves are relationships used to model unsaturated liquid flow through rock, and include moisture retention and hydraulic conductivity curves. The moisture retention of a material is controlled by the relationship between the suction within the matrix and the water content for a porous material. Hydraulic conductivity is the rate at which water can travel through a rock or soil sample under the influence of gravity. Generally, rocks and soils have higher hydraulic conductivities when more moisture is present, with the maximum hydraulic conductivity occurring when the material is fully saturated with water. This condition is the saturated hydraulic conductivity. Texture has a large impact on moisture retention and hydraulic conductivity as well, where low surface area materials (e.g., sand) have a higher hydraulic conductivity than high surface area materials (e.g., clays).

The volumetric moisture content for the units beneath MDA G range between 2 and 14% by volume, and the unsaturated hydraulic conductivity curves prepared for the PA/CA are very steep at such low moisture contents. This indicates that for a unit increase in water, there is a large increase in hydraulic conductivity. For example, in Unit 2 the unsaturated hydraulic conductivity changes from 10^{-12} cm per second (cm/sec) at 3% volumetric moisture content to 10^{-10} cm/sec at 5% volumetric moisture content. This also illustrates the effects of the physical characteristics discussed above. The slopes of the conductivity curves generally level out when the moisture content reaches 7% and indicate that the hydraulic conductivity remains relatively constant over a wide range of moisture content (between 10 and 30%). The conductivity curves steepen again when the moisture content exceeded 34%; however, the high moisture contents were obtained under experimental conditions and are not expected *in situ* except under very localized conditions (LANL, 1997).

The rate of moisture movement beneath Mesita del Buey is perhaps the most important parameter in modeling the subsurface transport of contaminants (LANL, 1997). Moisture movement largely controls the minimum time required for contaminants to potentially be transported from MDA G through the vadose zone into the regional aquifer. The moisture movement through the undisturbed vadose zone is complex and is further complicated at MDA G by man-made disturbances associated with waste management activities.

Three moisture-content zones are consistently shown within the subsurface at MDA G (LANL, 1997). The volumetric moisture content in the top few meters varies between about 3 and 12% and reflects the seasonal effects of precipitation and evapotranspiration. Between mid-mesa depths of about 8 and 23 m (25 and 75 ft), volumetric moisture content is quite low, from 0.5 to 2%. Below 25 m (80 ft), moisture content increases to between 9 and 19%. The mid-mesa dry zone occurs consistently near the surge beds at the base of Unit 2 of the Tshirege Member. Based on unsaturated hydraulic conductivity estimates, estimates of flux rates through the low moisture content region are negligible (LANL, 1997). Water-pressure profiles estimated beneath the mesa, using hydraulic properties from cores, suggest that moisture moves toward the base of Unit 2 from above and below. These observations are consistent with a hypothesis that the mesa is dried out to a significant extent by evaporation and air movement along surge beds and fractures that are prevalent near this horizon (LANL, 1997).

Different rates of moisture movement corresponding to the three moisture-content zones are inferred by several independent analyses. Although the analyses invoke simplifying assumptions, they provide consistent qualitative evidence of variable rates of moisture movement within and across Mesita del Buey (LANL, 1997). The inferred zones include:

- A near-surface zone with an apparent rate of moisture movement on the order of several mm per year (mm/yr);
- An intermediate zone through the mid-depths of the mesa with rates of moisture movement on the order of tenths or hundredths of mm/yr; and
- A deeper zone in which the apparent rate of moisture movement may be several centimeters per year (cm/yr).

The analyses corroborating the apparent variable rates of moisture movement include natural tracer analyses, unit hydraulic gradient assumption, moisture profile analysis, and vapor flux studies. Details of these studies are presented in Section 2.1.5.6 of the PA/CA (LANL, 1997) and are summarized below.

Natural tracers used to infer information about moisture in the vadose zone include chloride, ^{18}O, and ^{2}H (deuterium). These constituents are present in precipitation in relatively constant amounts and, thus, are present in vadose-zone pore water, which is derived from precipitation. Results of the chloride tracer analysis showed the near-surface and deep-mesa fluxes are high relative to the mid-mesa flux. In the shallow and deep zones, the inferred flux rates are on the order of 2 to 3 mm/yr (0.08 to 0.1 in. per year [in./yr]). In the intermediate zone, the inferred flux rates are between 0.03 to 0.8 mm/yr (0.001 to 0.03 in./yr). The steep slope on the cumulative water/cumulative chloride plot for the mid-mesa region indicates that cumulative chloride increases faster than cumulative water (i.e., water is being lost from the system at that location). Estimated chloride accumulation ages also suggest that water movement through Mesita del Buey is very slow (LANL, 1997).

The naturally occurring stable isotopes of oxygen and hydrogen (^{18}O and ^{2}H) are useful indicators of evaporation. The results of the stable isotope study were compared to the chloride profiles to test the deep evaporation hypothesis. It was concluded that surface evaporation effects are limited to the shallowest 1 to 2 m (3.3 to 6.6 ft), and that at depths of 5 m (16 ft) and deeper, there is strong evidence that there is an evaporative sink at intermediate depths in the mesa (LANL, 1997).

The average van Genuchten parameters may be used to estimate rates of moisture movement through the stratigraphic units using the unit hydraulic gradient assumption. Different rates are necessary to match the moisture conditions measured in the various units of the Bandelier Tuff. It was found that near the surface, the best fit to the field moisture data to a depth of approximately 5 m (15 ft) corresponds to a moisture movement rate between 0.01 and 10 mm/yr (0.0004 and 0.4 in./yr). In Unit 2 and Unit 1vu, the apparent moisture movement rate that matches the field moisture data is between 0 and 0.1 mm/yr (0 and 0.004 in./yr). In Units 1vc and 1g, a moisture movement rate of 1 mm/yr (0.04 in./yr) best matches the field data. The Tsankawi-Cerro Toledo and Otowi Member stratigraphic layers match field moisture data with a much larger apparent moisture movement rate on the order of 10 mm/yr (0.4 in./yr). These estimated rates support the hypothesis that moisture movement is not steady state, or that significant changes in movement of moisture occur at depths (LANL, 1997). One explanation that accounts for the results of this analysis is that water may be removed at intermediate depths by evaporation and vapor-phase diffusion.

The unit-gradient approximation was also used to identify depths within Mesita del Buey where moisture may be lost to evaporation or vapor-phase diffusion (LANL, 1997). A moisture profile analysis was performed, and the rates of moisture movement calculated as the gradient of moisture were plotted, as was the gradient of the vertical flux. The results suggest a downward flux and a source of moisture to depths of about 7 m (23 ft). Below this, to depths near 28 m (92 ft), the average vertical flux is small but downward and the source is very small. The average local flux in this low-moisture zone is -0.017 mm/yr (-0.0007 in./yr) and the average moisture source is -0.0013 mm/yr (-0.005 in./yr). A moisture peak at 30 m (100 ft) occurs at the vapor-phase notch (the base of Unit 1vc). Overall, the average rate of moisture movement near the surface is about 10 mm/yr (0.4 in./yr), with a large standard deviation suggesting high variability. The average rate of moisture movement through the middle depths of the mesa is very small, and in the vapor-phase notch portion is relatively large (0.73 mm/yr). Although increased moisture at the vapor-phase notch at MDA G may be interpreted as a moisture source from the relatively wet canyons, this hypothesis does not explain high moisture content values (10 to 20% volumetric) observed at the vapor-phase notch at other locations across the Laboratory where the notch is not coincident with a canyon bottom or other moisture source.

Another study to understand the potential influence of water moving within and out of the mesa in the vapor phase was conducted by analyzing the vapor flux through the mesa (LANL, 1997). Analyses were performed on neutron-probe moisture measurements from several boreholes at MDA G. The results of the study indicated that water moves predominantly in the vapor phase at depths between 12 and 23 m (40 and 75 ft). The results also indicate that a fairly wide region within the mesa is dominated by vapor-flux and that this region corresponds to the region of low liquid flux, discussed above. The vapor-flux analysis also suggests that vapor flux dominates rates of moisture movement in regions of the mesa where volumetric moisture is below 5%, and the magnitude of the vapor flux in the low moisture region of the mesa is about 1 mm/yr (0.04 in./yr). In addition, there is no apparent direction associated with the vapor movement; instead, vapor appears to move in different directions throughout the dry region (LANL, 1997).

Water-balance components through covers resembling the operational pit cover used at MDA G have been measured during studies of test plots at LANL. The data show that 87% of precipitation is lost to evapotranspiration, approximately 6% remains as infiltration below the root zone, and the remainder is retained in the surface soil. The data also indicate that moisture movement through a conventional vegetated crushed-tuff cover was greatest in the late winter and early spring when snowmelt occurred and evapotranspiration was low because vegetation was not active (LANL, 1997). In 1973, volumetric moisture measurements were made in holes augered into the covers over Pits 1 and 2 at MDA G. These pits were covered in 1961 and 1963, respectively. The measured volumetric moisture content was quite variable, with measurements of 12% and 17% by volume in Pit 1 and 4% and 8% by volume in Pit 2. Peak water concentrations occurred at depths of 2 m (6.6 ft) and decreased between 2 and 3 m (6.6 and 10 ft). The variation was tentatively attributed to differences in soil conductivity of surface slope (LANL, 1997). Using the unit-gradient assumption, these moisture measurements indicate infiltration rates between several mm/yr and several cm/yr within the covers at Pits 1 and 2.

The moisture content within Pit 37, which was open for several years, was measured periodically over a three-year period in the 1990s to better understand infiltration through disposal units at MDA G. This pit, while open, was expected to have moisture contents in excess of most of the covered pits at MDA G, since it was open longer than the average disposal pit. The pits are assumed to have, while open, higher infiltration rates than the surrounding mesa top, due to the lack of vegetation (transpiration). A maximum moisture content of about 11% by volume was measured at Pit 37, with a mean moisture content of approximately 8%. Using the unit approximation, the average rate of moisture movement through Pit 37 is 5 mm/yr (0.2 in./yr) at the average (mean) pit moisture content (LANL, 1997).

In 1976, horizontal boreholes were drilled approximately 1 m (3.3 ft) beneath a pit at MDA G that was closed in 1966. Moisture measurements at the same boreholes were made in 1992 with a neutron probe. The volumetric moisture content values beneath the pit were in the range of 1 to 4%, and were generally 1 to 2% higher beneath the pit than moisture content values away from the pit. These data suggest that pit excavation has a small effect on moisture contents beneath the pits (LANL, 1997).

1.6 Groundwater

The most recent projected depth to groundwater at Area L, based on currently available data, is approximately 1,000 ft (LANL, 2001a). Additional information on groundwater at TA-54 is provided in the "Characterization Well R-22 Completion Report" (LANL, 2002); the "Supplement to Quarterly Technical Report April-June 2001" (ER Project, 2001); and the "Quarterly Technical Report October-December 2001" (ER Project, 2002). The following are summaries of the information in those reports.

Well R-22 is located on Mesita del Buey, east of TA-54, and was funded and installed by LANL's Environmental Restoration (ER) Project. This well is one of the 11 regional aquifer (R) wells drilled to date as part of the “Hydrogeologic Workplan” (LANL, 1998) in support of the “Groundwater Protection Management Program Plan” (LANL, 1996). Well R-22 is the first of five planned regional aquifer wells at or in the vicinity of TA-54. This well was designed primarily to provide water-quality and water-level data for potential intermediate-depth perched zones and for the regional aquifer downgradient of TA-54. In addition, it was designed to collect geologic, hydrologic, and geochemical data that will contribute to the understanding of the vadose zone and regional aquifer in this area of LANL. Although the location of well R-22 was originally proposed for installation in Pajarito Canyon, just south of Mesita del Buey, its final location was changed to the mesa top in order to be in closer proximity to and more directly downgradient of TA-54 and to be better suited for a future monitoring well.

Well R-22 was drilled to a total depth of 1,489 ft in 2000. A multiscreen well containing five screened intervals that can be sampled individually was installed. In descending order, the geologic units encountered during drilling consisted of ash flows of the Tshirege and Otowi Members of the Bandelier Tuff (including the basal Guaje Pumice Bed); lavas, cinder units, interflow units, and subflow deposits of the Cerros del Rio volcanic field; an upper sequence of fanglomerate deposits of the Puye Formation; an older basalt; and a lower sequence of fanglomerate deposits of the Puye Formation. Depths and elevations of the contacts between these units are shown in the “Characterization Well R-22 Completion Report” (LANL, 2002). Notable differences between the predicted and as-found stratigraphy at this well was the greater thickness of the Cerros del Rio volcanic sequence, the absence of Puye Formation axial river gravels, and the absence of Santa Fe Group sediments within the drilled depth.

Two potential perched zones and one regional zone of saturation were originally predicted at well R-22. Two zones that could potentially support perched water were predicted at a depth of 148 ft in the Cerros del Rio basalt and at a depth of 487 ft in the Puye Formation. The regional water table was anticipated to be at a depth of 922 ft in the Puye Formation at the well R-22 location. No water was encountered, however, until the drillers first noted water at a depth of approximately 890 to 900 ft. After 30 minutes, the water-level depth was measured at 883.05 ft. The water is believed to be associated with the regional zone of saturation because the regional water table was projected to be at a similar depth, no obvious perching horizon was encountered, and saturation continued to the total depth drilled.

Both a direction and a rate are required to characterize groundwater movement. Although the data from this single well do not allow a determination of horizontal flow direction, vertical direction can be evaluated by analysis of head distribution along the borehole. In addition, the hydraulic properties of the saturated materials (determined from analysis of field testing data) provide a general idea of potential flow rate. During drilling, hydraulic heads obtained during testing clearly indicated a downward vertical gradient at well R-22. The downward vertical gradient at well R-22 was supported after testing by a piezometric profile constructed using a pressure-measurement system.

Field tests at depth targeting for screened intervals were performed during drilling to determine hydraulic properties at well R-22. The five screened intervals were distributed through the zone of saturation. Hydraulic conductivities ranged from 0.27 ft/day (ft/d) to 2.32 ft/d at four screened intervals, based on straddle-packer/slug-injection tests performed.

Extensive borehole geophysical data were collected during drilling. Borehole video and natural gamma radiation surveys were conducted, and a suite of borehole geophysical logs was obtained. The surveys were conducted in cased hole from the surface to a depth of 1,330 ft. Below 1,330 ft, the surveys were conducted in open hole. Geophysical logging in open hole included caliper, resistivity, natural gamma radiation, spontaneous potential, lithodensity, magnetic resonance, borehole color video, epithermal neutron, neutron porosity, and spectral natural radiation. Volumetric water content beyond the casing in the vadose zone was measured using a Compensated Neutron Tool as a means to evaluate moist/porous zones and to estimate porosity in the saturated zone. Overall and spectral natural gamma ray activity was measured using a Hostile Natural Gamma Spectroscopy tool as a means to evaluate geology and lithology and the presence of clay versus sand. As a means to characterize mineralogy, lithology, and water content of the formation, concentrations of hydrogen, silicon, calcium, sulfur, iron, potassium, titanium, and gadolinium were measured using an Elemental Capture Spectroscopy tool. To measure bulk density and photoelectric effect as a means to estimate total porosity and characterize lithology, a Litho-Density Tool was used. Calibrated gross gamma ray readings were recorded to match the depth of the logging runs. The log results indicated that at the time of logging, a well-water level of 995 ft below ground surface (bgs) was recorded and that the probable regional groundwater level was 886 ft bgs. The log results also showed increased vadose zone moisture content (an average of 5%) in the intervals between 50 and 180 ft bgs, and 10% or greater between 350 and 715 ft bgs. In addition, in the interval from 1,405 to 1,478 ft (the total log depth), log data indicated an increased saturated zone porosity (greater than 40%) corresponding to the Lower Puye Formation. Clearly defined stratigraphic/lithologic boundaries were also indicated from the spectral gamma and geochemical logs.

During drilling, samples of groundwater were collected from depths of 883 ft and 1,489 ft. The potential contaminants of concern at the well R-22 location include VOCs, perchloric acid, tritium, and other radionuclides (LANL, 2002). The samples were analyzed for major anions, VOCs, semivolatile organic compounds, high explosives (HE), radionuclides, and stable isotopes. Samples collected for major anions analysis were filtered; nonfiltered samples were collected for the remainder of the analyses. Due to the presence of drilling fluids, the borehole water samples are not representative of groundwater.

While the following compounds are not subject to regulation under the hazardous waste program, data are provided herein for informational purposes only. Upper zone borehole water showed concentrations of bicarbonate (120 milligrams per liter [mg/L]), chloride (21 mg/L), fluoride (1.19 mg/L), oxalate (1.05 mg/L), and sulfate (19.9 mg/L). Oxalate may be produced by the breakdown of one of the drilling fluids used, and can occur naturally at very low concentrations in groundwater and surface water around LANL and elsewhere (Broxton et al., 2001).

Methylene chloride was also detected at a level above the instrument detection limit but less than the practical quantitation limit. This chemical is used in analytical laboratories for extraction during gas chromatography/mass spectrometry analyses and may provide a source of laboratory contamination. Concentrations of bromide, phosphate, and perchlorate were less than detection. Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) was detected at a concentration of 90 micrograms per liter (µg/L). Based on similar chemical structures between RDX and one of the drilling fluids used, this result is believed to be a false positive. The HE compound 2-A-4,6-DNT was also detected above the instrument detection limit but below the practical quantitation limit. The U.S. Environmental Protection Agency *SW-846* Method 8330, which uses high-performance liquid chromatography, is susceptible to false positives for HE compounds and degradation products. Consequently, an alternative and more accurate analytical method using diode array was used when the analytical laboratory reran the sample; the results using this analytical method showed that HE compounds and degradation products were less than detection (0.25 µg/L). A further discussion about the investigation of false positives for HE compounds and associated degradation products is presented in Section 13.2 of the "Characterization Well R-22 Completion Report" (LANL, 2002). During characterization in the completed well, additional groundwater samples will be collected to evaluate the presence or absence of HE compounds at well R-22. Acetone at a concentration of 0.820 mg/L was detected at the regional water table during drilling at well R-22. An investigation was conducted to determine the source of this organic compound, which may be present due to oxidation of one of the drilling fluids that contains isopropyl alcohol. Based on this investigation, the mass spectra from the initial analysis demonstrated high concentrations of isopropyl alcohol in the injection water used during drilling at well R-22. The isopropyl alcohol had in fact been misidentified as acetone by the analytical laboratory.

As previously mentioned, the following compounds are not subject to regulation under the hazardous waste program; however, data are provided herein for informational purposes only. Tritium was present at an activity of 109 picocuries per liter (pCi/L); this screening value suggests that the age of the tritium is less than 60 years old. More recent sampling shows lower tritium levels. During the first round of groundwater sampling in March 2001, tritium levels ranged from 2 to 77 pCi/L. During the second round of sampling in June 2001, tritium levels continued to decrease and ranged from 1 to 14 pCi/L. (The Drinking Water maximum concentration level [MCL] for tritium is 20,000 pCi/L.) Activities of americium-241, plutonium-238, plutonium-239/-240, and strontium-90 were less than detection. Activities of uranium-234, uranium-235, and uranium-238 were at levels of 1.48, 0.126, and 1.41 pCi/L, respectively. Nitrogen isotopes were analyzed for the water sample collected at 1,489 ft to evaluate the source(s) of nitrate at well R-22. The $\delta^{15}N(NO_3)$ value was +9.6 permil, which suggests that the water sample is enriched with nitrogen-15.

The Cerros del Rio lavas at well R-22 were nearly three times thicker than predicted (983 ft vs. 339 ft). The most significant hydrogeologic impact of this thick set of lavas is that the regional water table is within these lavas rather than within Puye Formation fanglomerates. Therefore, all flow and transport within the upper ~300 ft of the regional aquifer is within basaltic fractures and interflow rubble rather than through Puye Formation pore spaces. This difference in stratigraphy implies different flow rates and pathways, and the lavas provide an environment in which certain constituents (e.g., ferrous iron) can influence water chemistry.

Several features contribute to the peculiarities of the as-drilled stratigraphy at well R-22. It is believed that the exceptional thickness of the Cerros del Rio lavas and cinder indicate fill within a paleocanyon. The absence of axial river gravels at the base of the Cerros del Rio volcanics suggests that the paleocanyon was not a through-going drainage ancestral to the modern Rio Grande. Because cuttings were not returned from some key intervals beneath the Cerros del Rio lavas, it is possible that axial river gravels may have been present within 5 ft of the base of the lavas but were not sampled. Therefore, the orientation of the paleocanyon (east-west vs. north-south) is uncertain.

The first round of groundwater sampling at well R-22 was conducted in March 2001 and the available data were reported in the supplement to the "Quarterly Technical Report April-June 2001" (ER Project, 2001). As noted in that supplement, because of a delay in analytical services, the $^{15}N/^{14}N$ isotopic suite was not available and would be reported at a later date. In addition, the supplement noted that because of an ongoing focused validation effort by the contract analytical laboratories, HE data were not available for reporting. No organics were found to exceed Drinking Water MCLs or NMED Groundwater Standards.

As indicated in the "Quarterly Technical Report October-December 2001" (ER Project, 2002), the second round of sampling at well R-22 was completed in June 2001. The data reported include field parameters and organic, inorganic, and radiological constituents. Because of analytical laboratory backlog, stable isotopes of nitrogen ($^{15}N/^{14}N$) were not available for inclusion in that report. In addition, because of an ongoing focused validation effort by the contract analytical laboratories, HE data were not available for reporting. Lead was found in Screen 3 (1,273 ft in depth) at a concentration of 19.7 µg/L. The Drinking Water MCL for lead is 15 µg/L; the NMED Groundwater Standard of 50 µg/L was not exceeded. No organics were found to exceed Drinking Water MCLs or NMED Groundwater Standards.

The third groundwater sampling round for well R-22 was conducted in November 2001; results of this sampling effort will be included in a quarterly report once the data are validated. The fourth groundwater sampling round was scheduled for March 2002, and the results will be provided in a subsequent quarterly report upon completion of data validation.

2.0 HYDROGEOLOGIC WORKPLAN CHARACTERIZATION ACTIVITIES

Pursuant to U.S. Department of Energy Order 5400.1, the LANL "Groundwater Protection

Management Plan" was developed in 1995, which identified the need for site-wide hydrogeologic characterization. In the same year, NMED denied LANL's previously submitted groundwater monitoring waiver demonstrations. In a letter dated August 17, 1995, the NMED requested that LANL prepare a "Hydrogeologic Workplan." Hence, LANL began developing the "Hydrogeologic Workplan" (LANL, 1998) that, upon implementation, would collect data on the hydrogeologic setting. These data would be useful for making decisions regarding monitoring and environmental restoration using the Data Quality Objective (DQO) process. The workplan was approved by the NMED in March 1998.

The primary purpose of the "Hydrogeologic Workplan" is to gain an understanding of the hydrogeologic setting that is adequate to design a detection monitoring network capable of detecting water quality threats to the regional aquifer. As stated in the Executive Summary of the workplan, the expected outcomes of implementing the plan's activities are:

- A "refined understanding of the hydrogeologic framework at the Laboratory, including recharge areas, hydraulic interconnections, flow paths, and flow rates, synthesized by modeling simulations;
- Information sufficient either to design and implement a detection monitoring program that meets applicable requirements and/or to demonstrate that groundwater monitoring requirements can be waived; and
- Defined areas of existing or potential groundwater contamination, and the potential pathways of contaminant transport from the surface to the regional aquifer, with predictions of directions and rates of movement and risk based on modeling simulations."

A series of decisions established in the plan were intended to focus data collection activities on information important to a better understanding of the hydrogeologic regime as well as monitoring design. Areas with the highest potential for contaminant impacts are where hydrogeologic data collection is more focused. The potential pathways and rates of contaminant migration can be determined using the resulting data and analyses. One workplan objective is to identify areas of groundwater contamination. Determining the extent of contamination and risk posed by that contamination is conducted by LANL's ER Project because investigation of contaminant plumes is not within the scope of the "Hydrogeologic Workplan" (LANL, 1998).

The "Hydrogeologic Workplan" provides for an iterative process of gaining understanding from each activity, especially from installed wells. This iterative process is then used in guiding the succeeding DQOs and the location and data collection of subsequent wells. Although the interpretive process is not as highly visible as data collection, it is equally as important as the well installation and data collection. A primary tool used to interpret data collected from drilling and testing in the wells is numerical modeling. When sufficient new data and data interpretation have been accomplished to change the conceptual understanding, the iteration process is conducted. The data collection and modeling reached a level of maturity in Fiscal Year (FY) 01 to allow iteration of the DQOs. The FY 01 DQO iteration process began with a comprehensive evaluation of all groundwater-related data collected, analyzed, and interpreted in the program at that time. This process resulted in a determination of what is known and what data are required to complete the scope of the workplan. The comprehensive evaluation and the FY 01 DQO process iteration resulted in proposed amendments to the scope of the workplan (LANL, 2001b).

Initially, 32 regional aquifer wells were proposed in the “Hydrogeologic Workplan”. As of April 2002, 11 R wells have been installed. LANL’s Groundwater Integration Team worked together to determine which of the remaining wells and other studies are still necessary to complete the scope of the workplan, and added new studies as appropriate to provide the data. The current proposed amendments to the “Hydrogeologic Workplan” scope include installing 15 more R wells, and eliminating 6 R wells. The proposed scope also includes 13 field-based activities, 11 analytical activities, and three project management activities.

In the “Hydrogeologic Workplan”, the activities proposed to characterize the hydrogeologic setting beneath LANL and to enhance LANL’s groundwater monitoring program are summarized by “aggregates”. The aggregate boundaries were drawn to focus discussions and attention on specific areas of LANL that collectively contain numerous sources of potential contamination. However, the hydrogeologic characterization activities relevant to a particular aggregate are proposed within as well as outside the aggregate boundaries.

Aggregate 2, located in the east-central portion of LANL, is bounded on the north by Cañada del Buey, on the south by Pajarito Canyon, on the west by TAs 18 and 51, and on the east by the LANL boundary. Essentially, the boundary of Aggregate 2 was drawn to encompass the solid waste management units associated with TA-54. It includes Cañada del Buey, the middle reach of Pajarito Canyon, and Mesita del Buey, where TA-54 is located.

In the initial workplan, one R well (well R-16) was planned for installation in Cañada del Buey east of the Aggregate 2 boundary. The purpose of this proposed well was to provide stratigraphic and hydrologic control off site near the Rio Grande and to provide an off-site detection monitoring point downgradient of LANL activities. In addition, two R wells (well R-20 and well R-22) in Pajarito Canyon were proposed for Aggregate 2 to identify the presence of intermediate perched zones, measure the thickness of the zones, and analyze for the presence of contaminants within the zones that could indicate actively occurring contaminant transport. As noted in Section 1.6, well R-22 was installed in 2000 on the mesa top just east of the TA-54 disposal areas. The location of this well was changed from its original siting in Pajarito Canyon to determine if perched zones are present beneath Mesita del Buey and to better understand the hydrogeologic conditions just east of the disposal areas at TA-54. Other proposed R wells for Pajarito Canyon included wells R-17, R-18, and R-19, which would provide information about sources in other aggregates upgradient of Aggregate 2; they are not discussed further in this attachment. Also in the initial workplan, one R well (R-21) was proposed for installation on Mesita del Buey near MDA L. The purpose of this proposed well is to evaluate and monitor hydrologic and geochemical conditions in the regional aquifer beneath MDA L. Data from well R-21 will be compared to data from well R-20, just northwest of Aggregate 2, to evaluate migration of organic contaminants, potential pathway behavior, and potential contaminant movement toward supply well PM-2. Recently, it was determined that an additional well (well R-23) be included in Aggregate 2. Well R-23 is proposed to be located in Potrillo Canyon, approximately 3,700 ft south of Area G. This well will provide water-quality and water-level data for potential intermediate perched zones and the regional aquifer. It will also provide data that may be used to calibrate the potential for a southeasterly groundwater flow direction, evaluate recharge, and determine the presence of perched zones and the influence of the regional aquifer in the area of a hydrologic sink. It should be noted that the locations of the four additional R wells associated with Aggregate 2 (wells R-16, R-20, R-21, and R-23) are subject to change as the DQO iteration process continues.

3.0 REGIONAL AQUIFER HYDROLOGIC MODELING

A hydrologic model for the Pajarito Plateau beneath LANL is an important tool for protecting groundwater that could potentially be impacted by past Laboratory operations. The purpose of modeling the regional aquifer is two-fold. First, the model can be used to synthesize hydrologic, geochemical, and geologic data relevant to the regional aquifer. Second, the model can be used to predict flow directions and velocities as well as technically defensible estimates of uncertainty in the predictions.

A numerical groundwater model for the Pajarito Plateau beneath LANL was developed in 1998 and has been refined continuously as new groundwater data are collected. From the detailed technical descriptions of the modeling efforts, a simplified description is presented in the following. The simplified description addresses the purpose of modeling, why the model code was selected, the elements of the conceptual model, and modeling calibration and results.

3.1 Introduction

In the dictionary, a "model" is defined as a "small representation of a planned or existing object". A numerical groundwater model has flow equations that represent the physical processes of water flowing through the subsurface. From the earth's surface, groundwater movement cannot be observed directly; therefore, numerical groundwater modeling is used as a tool to understand groundwater flow. In a simple sandy aquifer, it is possible to derive groundwater flow directions and velocities using water level data, pump test data, and pencil-and-paper calculations. In a geologically complex aquifer such as that which exists beneath the Laboratory, however, is it not feasible to derive flow directions and velocities from hydrologic data without the assistance of a computer model. In addition, models are useful in that they provide a range of plausible answers, using the available hydrologic data set and understanding of the varied character of the aquifer.

Development of a numerical groundwater model for the regional aquifer beneath the Laboratory was initiated in 1998 and has been continuously refined as new groundwater data are collected. The description presented herein of the modeling efforts has been greatly simplified from the detailed technical descriptions of the modeling efforts found in the reports in Keating et al. (1998, 1999, 2000, and 2001). The following sections describe the model code, conceptual model, flow model development, calibration, and sensitivity analyses. Accordingly, LANL intends to use groundwater models to aid in many decisions, such as where monitoring wells are best placed and what additional data are needed.

3.2 Purpose of Modeling

A hydrologic model for the Pajarito Plateau beneath the Laboratory is an important tool for protecting groundwater that could be impacted by past Laboratory operations. The purpose of modeling the regional aquifer is two-fold: (1) to synthesize hydrologic, geochemical, and geologic data relevant to the regional aquifer; and (2) to predict flow directions and velocities, along with technically defensible estimates of uncertainty in those predictions.

There are at least three modes of groundwater beneath the Pajarito Plateau: (1) groundwater in alluvium in some canyons; (2) perched intermediate groundwater (groundwater above a less permeable layer that is separated from the underlying groundwater by an unsaturated zone at intermediate depths (150-400 ft); and (3) the regional aquifer, which is separated from the upper groundwater by hundreds of ft of tuff, basalts, and volcanic sediments in the western portion of the Laboratory, with the vadose zone becoming thinner to the east. The regional aquifer beneath the Pajarito Plateau provides the community and Laboratory water supply.

Hydrologic models have two parts that work together: the conceptual model and the numeric model. The conceptual model is the synthesis of all the known geologic and hydrologic data, which provides the estimated input parameters for the numeric model. The numeric model uses mathematical equations to translate the rock and water properties to numbers. A model is "calibrated" when the numbers that result from the numeric model match reasonably well to actual observations (e.g., water levels in wells). The process of calibrating a model involves revising the conceptual and numeric models consistent with the known data until there is reasonable match between model outputs and observed data. After calibration, the regional aquifer model is used for sensitivity analyses. Sensitivity analyses are a tool to evaluate the uncertainty of the model by testing how much each of the inputs affects the outcome of the model. Those inputs that have a big effect on the model outcome are considered "sensitive" and the input values should be based on appropriate site-specific data. Those inputs that do not affect model outcomes are "insensitive" and are not as important to site-specific data.

3.3 Model Code Selection

The numeric model is the computer code that runs calculations with the input parameters provided. The numeric model selected by the Laboratory is the Finite Element Heat and Mass (FEHM) computer code. It was developed at the Laboratory for the High-Level Radioactive Waste Repository Program. It simulates the flow of water and air and the transport of heat or substances in water through saturated or partially saturated rock. It can simulate flow or transport in either 2-dimensions or 3-dimensions. It was selected because it has been rigorously tested and certified for use in radioactive waste disposal and because its capabilities match the specific investigation needs at the Laboratory. For example, FEHM can be used for both unsaturated and saturated flow modeling, both of which are important at the Laboratory. This computer code is publicly available from LANL.

At the outset of the modeling effort, the decision was made to develop a regional-scale model of the Española Basin. Modeling the Española Basin was selected as a platform for the Pajarito Plateau model as it would incorporate all the existing hydrogeologic information and aquifer stress data in terms of water supply wells and streams. The large areal extent of an Española Basin model also allowed use of simulated data for boundary conditions that were needed for the Pajarito Plateau model. Obtaining distant, but accurate, boundary conditions improves the overall accuracy and reliability of the model.

The Pajarito Plateau-scale model grid was developed using the Octree Mesh Refinement methods to embed a high-resolution zone within the relatively coarse Española Basin grid. The grid is better suited to capture site-scale flow and transport processes in areas of interest, while allowing boundary conditions from the Española Basin-scale model to be applicable without adversely affecting the computation time or the computer memory required to run the model. The smaller-scale model uses calculated values of head and flux from the large model to define boundary conditions in the smaller-scale model. The grid spacing in the Pajarito Plateau portion of the model is finer grid spacing than the Española Basin-scale model (Table 1).

3.4 Conceptual Model of Flow

The conceptual model that is the basis of the regional aquifer modeling efforts extends throughout the Española Basin. Elements of the conceptual model are the **boundaries** of the model, the **hydraulic gradient**, **aquifer properties**, **recharge**, and **discharge**.

The **boundaries** of the model are based on the physical boundaries of the regional aquifer within the Española Basin. The basement rocks and surrounding uplifts and mountains that define the Española Basin also define the aquifer boundaries in the model. In the model, the aquifer boundaries are areas where there is expected to be little flow because the aquifer material does not extend beyond the boundary. The exception is the La Bajada Fault, which forms the southern boundary of the model area. Others (Kernodle et al., 1995) have estimated the flow across the La Bajada fault. The Española Basin is a low area bounded by high areas:

- Sangre de Cristo Mountains on the east
- Nacimento uplift to the west
- La Bajada Fault on the south

- To the north, the Brazos uplift and Picuris Range
- Lower boundary is the basement rocks of the Española Basin, which are metamorphic rocks that can also be seen in the Sangre de Cristo Mountains
- The upper boundary is the water table of the regional aquifer.

Of the boundary conditions, the upper boundary is considered the most important because that is where all the recharge occurs. The other boundaries represent hydrologic divides, where little water enters or exits the basin. The upper boundary surface is the water table of the regional aquifer. The grid nodes on the upper boundary surface are assigned one of three kinds of boundary conditions. The first kind of boundary condition is for nodes that occur in one of the major rivers (Rio Grande or Rio Chama). The boundary condition for the nodes in the rivers allows water to either flow into or out of the river, depending on if the water table is higher than (water flows out of the aquifer into the river) or lower than (water flows out of the river and into the aquifer) the river. The elevation of the river grid nodes was set at the elevation of the river.

The second kind of boundary condition for the upper model boundary is the higher elevation where recharge occurs. These grid nodes are set to allow a specific amount of water into the regional aquifer. The amount of water at each grid node was calculated based on the elevation of the land surface. This approach was taken because a graph of actual precipitation measurements at stations of different elevation in the Española Basin shows a linear relationship - the higher the elevation, the higher the precipitation. It was also assumed that the percent of precipitation reaching the water table increases with increasing elevation. This assumption is based on the observation that at higher elevations, the temperature and vegetation cover are both less, so the evaporation and transpiration (use of water by plants) are both expected to be lower; thus, more water is available to infiltrate the ground surface. In the numerical model, for every node above the threshold elevation of 6,000 ft (the elevation at which evaporation is greater than precipitation, so no water recharges), the amount of precipitation assumed was based on the linear trends of increasing precipitation and infiltration with elevation.

The third type of boundary condition on the upper boundary of the 1998 model were assigned to nodes that had elevation of less than 6,000 ft and were not in the river channels. These nodes were assigned a no-flow condition, because water is not expected to enter or exit the regional aquifer in these areas.

The northern and southern lateral model boundary conditions near the rivers are set to allow flow into or out of the model and the water levels are specified values. The values that are specified for these boundary grid nodes are based on the elevation of the water table at the surface for surface grid nodes; for the grid nodes beneath the surface, the value assigned is calculated assuming a hydrostatic pressure gradient. The amount of water flowing in along the northern boundary of the model is initially taken from estimates of water from the San Luis basin to the north (Coon and Kelly, 1984). Along the southern boundary, the amount of water exiting the Española Basin to the south was based on estimates by Kernodle et al. (1995) and Frenzel (1995).

The majority of the remaining boundaries were assigned no-flow boundary conditions:

- The crest of the Sangre de Cristo Mountains on the eastern model edge
- The top of the Sierra de los Valles (east of the Jemez Mountains geothermal field and west of the Pajarito Fault zone) on the western model edge
- Top of the Brazos and Picuris ranges
- The Española Basin basement at the base of the model.

The topographic divides (Sangre de Cristo, northern ranges, and Sierra de los Valles) are assumed to approximate the hydrologic divides. However, the actual location of the groundwater divide on the western edge of the Española Basin is unknown and must be evaluated further. The grid nodes are assigned no-flow boundary conditions. Although some water may flow through the basement, the contrast between the overlying sediments filling the basin and the metamorphic rocks is expected to be big enough that water will not enter the materials below the basement.

There are two components of **hydraulic gradient**: horizontal and vertical. The horizontal hydraulic gradient is determined by the water levels that have been measured in wells throughout the basin. The vertical gradient is determined by measuring the water levels at different depths in the aquifer. The horizontal hydraulic gradients at the Española Basin scale are fairly well known and show that the flow of water is generally from the high areas on the east and west of the basin toward the Rio Grande in the center of the basin. The horizontal gradients for the Pajarito Plateau are shown in Table 2. On the Española Basin scale, vertical upward gradients have been reported in several wells fields near the Rio Grande (Buckman, lower Los Alamos, and Santa Clara Pueblo, Tesuque Pueblo). On the Pajarito Plateau, vertical gradients have been measured in a number of wells. The measured vertical gradients are shown in Table 3.

The **aquifer properties**, primarily permeability, are assumed to be controlled by the geologic characteristics of the rocks. The Española Basin gradually accumulated sedimentary rocks formed by sediments eroded from surrounding high areas and volcanic rocks erupted from different volcanic centers. The sedimentary rocks generally contain the regional aquifer within the Española Basin. For the regional aquifer model, 20 layers representing different types of rock units (hydrostratigraphic zones) were used (Table 4). In addition, vertically-oriented hydrostratigraphic units representing fault zones were included in the model. Each layer was assigned hydraulic properties based largely on hydrologic data that have been collected and the geologic character of the layer where no data are available.

Aquifer **recharge**, the amount of water entering the aquifer, is a generalized recharge model, assuming that the first order control on recharge rates is elevation. The conceptual model of recharge is that most water recharging the aquifer originates in stream channel bottoms. For major channels in the basin, this is modeled explicitly. However, for most of the model domain, recharge is applied uniformly within any given elevation range ("diffuse" recharge), making no distinction between canyons and mesas. This effectively "spreads" the focused recharge occurring in canyon bottoms over a larger area. This approximation is appropriate for estimating the total amount of water recharging the system in various elevation ranges, for estimating baseflow discharge to rivers, and for estimating hydraulic gradients in the regional aquifer at scales of kilometers.

Groundwater **discharge** to rivers is an extremely important constraint on the regional aquifer model. Surface water flow data from twelve rivers in the basin are used to determine the baseflow. Quantified downstream increases in baseflow are attributed to regional aquifer discharge.

3.5 Regional Aquifer Modeling Calibration and Results

The regional aquifer model has been calibrated in two modes: steady-state and transient. Since 1945, the water levels in the Pajarito Plateau area have declined due to extensive development of the aquifer. The steady-state mode is calibrated using "pre-development" data, prior to 1945. There are pre-development data from 93 wells basin-wide, 34 of which fall within the Pajarito

Plateau sub-model. The transient mode is calibrated using transient drawdown due to pumping in 14 wells. The transient data are available for every year since 1945. The transient simulations were done in 10-year time steps, so the 10-year average pumping rates were derived from the annual pumping data for all the wells in the Pajarito Plateau sub-model.

Both the steady-state Española Basin model and the Pajarito Plateau sub-model provided reasonable simulation of head and flux measurements. The calibrated steady-state model was used for inverse calculations to estimate model parameters. The steady-state Española Basin inverse model was used to estimate 37 model parameters: 3 recharge and 34 permeability. This process suggested that the permeabilities of the two largest hydrostratigraphic units in the basin are well constrained. However, estimates for several smaller units are poorly constrained. The steady state Pajarito Plateau inverse sub-model estimated 20 model parameters: 3 recharge and 17 permeability. The sub-model and basin-scale model results were very similar; the largest discrepancies are for two relatively small hydrostratigraphic units. For one of these, the sub-model estimate was closest to pump test data; for the other, the sub-model estimate was farthest from the pump test data.

The addition of transient observations in the inverse process greatly decreased the uncertainty of estimated parameters. For the sub-model, the transient observations allowed an improved steady-state flux and water level matches. A comparison of the steady-state to the steady-state plus transient estimates shows that the major changes are associated with the permeability of the two potentially important hydrostratigraphic units. The uniform specific storage estimated by the transient inverse model is close to the independent estimates derived from hydraulic testing.

The results of the regional aquifer model are a refined water level map and estimates of flux across the boundaries, as presented in Keating et al. (2000). Vadose zone modeling at TA-54 will be used as inputs into the regional aquifer modeling (e.g., recharge estimates) to determine the fate of contaminants from a source at TA-54, if any, in the regional aquifer.

Table 1: Grid Spacing in Española Basin-scale Model and the Pajarito Plateau Portion of the Model				
Model	**North- South (X)**	**East-West (Y)**	**Vertical (Z)**	**# Nodes**
Española Basin-scale model	1000 m	1055 m	50 m above 1300 m depth	277,951
	1000 m	1055 m	500 m below 1300 m depth	
Pajarito Plateau portion	250 m	264 m	12.5 m above 1550 m elevation	172,741
	250 m	264 m	50 m above 1100 m depth	
	250 m	264 m	500 m below 1100 m depth	

Table 2: Horizontal Gradients on the Pajarito Plateau

Upgradient Well	**Water Level Elevation (m)**	**Down-gradient Well**	**Water Level Elevation (m)**	**E-W Distance (m)**	**Gradient (m/m)**
R-25	1836	CdV-15-3	1833	2189	0.02884
CdV-15-3	1833	R-19	1795	4710	0.02149
DT-10	1805	R-22	1747	5195	0.01121
R-15	1785	R-12	1738	3684	0.01283

Table 3: Vertical Gradients on the Pajarito Plateau

Well	Vertical Gradient	Comment
R-19, screen 6	0.08	weakly upward
R-19, screen 7	0.28	weakly downward
R-25, screen 3	1.72	strongly downward
R-25, screen 4	0.86	weakly downward
R-25, screen 5	1.10	downward
R-25, screen 6	0.15	weakly downward
R-25, screen 7	0.13	weakly downward
R-25, screen 8	0.13	weakly downward
CdV-15-3, screen 6	0.02	weakly upward
R-31, screen 3	0.01	nearly neutral
R-31, screen 4	0.01	nearly neutral
R-31, screen 5	0.02	nearly neutral
R-22, screen 2	0.07	nearly neutral
R-22, screen 3	0.14	weakly downward
R-22, screen 4	0.11	weakly downward
R-9/PM-1	0.05	weakly upward
R-9/O-1	0.03	weakly upward
TW-3/O-4	0.05	weakly upward
TW-1/O-1	0.10	weakly downward

Table 4:	**Hydrostratigraphic Units**		
Rock Type	**Hydrostratigraphic Layer**	**Volume (10^{10} m^3)**	**Permeability (m^2)**
Crystalline Rock	Deep Basement (Precambrian	400.8	5.00×10^{-16}
	Fractured Paleozoic/Mesozoic	214.2	
	Paleozoic/Mesozoic	181.7	2.00×10^{-17}
	Cerros del Rio Basalts	0.4	1.00×10^{-15}
	Cerros del Rio Basalts - southern	2.2	1.00×10^{-16}
	Tschicoma Formation	57.1	7.10×10^{-16}
Fault Zones	Pajarito	17.6	2.13×10^{-15}
	Agua Fria	0.1	4.49×10^{-15}
Sedimentary Rocks	Santa Fe Group east	47.4	2.07×10^{-13} horizontal 2.07×10^{-15} Vertical
	Santa Fe Group west	171.2	1.4×10^{-13} horizontal 1.4×10^{-15} Vertical
	Ancha Formation	3.4	1.34×10^{-13} horizontal 1.34×10^{-15} Vertical
	Santa Fe Group north	90.3	1.50×10^{-14}
	Ojo Caliente sandstone	61	2.20×10^{-14}
	Peñasco Embayment	38.5	4.67×10^{-13}
	Santa Fe Group - deep	162.4	1.21×10^{-14}
	Santa Fe Group- near airport	8.2	1.00×10^{-11} horizontal 1.00×10^{-13} Vertical
	Santa Fe Group - Chaquehui Formation	2.6	1.00×10^{-13}
	Puye - fanglomerate	0.4	2.38×10^{-13}
	Puye - totavi lentil	0.5	1.00×10^{-13}
	Bandelier Tuff	0.1	3.95×10^{-14}
Total Model Volume		**1620**	

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ATTACHMENT C

NATURE AND EXTENT OF RELEASES AND PRESENT-DAY RISK ASSESSMENT FOR TECHNICAL AREA 54, MATERIAL DISPOSAL AREA L

NATURE AND EXTENT OF RELEASES AND PRESENT-DAY RISK ASSESSMENT FOR TECHNICAL AREA 54, MATERIAL DISPOSAL AREA L

A Resource Conservation and Recovery Act Facility Investigation was conducted at Technical Area 54, Area L, from 1993 to 2001 to determine if releases had occurred and to characterize the nature and extent of the releases. The most recent information on the nature and extent of contamination at Material Disposal Area L is summarized in this attachment. The report also addresses the assessment of present-day risks. The information in this attachment is submitted as a portion of the response to the December 21, 2001, letter from James P. Bearzi (Chief, New Mexico Environment Department Hazardous Waste Bureau) to Dr. John C. Browne (Director, Los Alamos National Laboratory) and Mr. David A Gurulé (Area Manager, Department of Energy Los Alamos Area Office).

SWMU 54-006	Material Disposal Area (MDA L) (all subsurface units such as Pit A, SI B,C,D, Shafts 1-28, 29-34)
Administrative Authority NMED	Former Operable Unit OU 1148
Technical Area TA-54	Dates of Operation 1959-1986
Has ER Sampled the Site? Yes	ER Remedial Action Conducted? No
Structure Number N/A	Other Remedial Action Conducted? No

Unit Description

SWMU 54-006 (also called MDA L) is included in Module VIII of LANL's Hazardous Waste Facility Permit. Area L is a 2.5-acre fenced area that includes MDA L, which consists of 1 subsurface disposal pit (pit A); 3 subsurface treatment and disposal impoundments (impoundments B, C, and D); and 34 disposal shafts (shafts 1 through 34). Only impoundments B and D and shafts 1, 13-17, and 19-34 (although no longer in use) are considered active impoundments until RCRA closure is certified and approved. The entire fenced surface area of Area L is an active RCRA-permitted hazardous waste management unit.

Disposal pit A is located in the eastern portion of Area L beneath Dome 54-215. The pit is 200 ft long x 12 ft wide x 12 ft deep. It received chemical waste from the late 1950s until December 1978. Initial waste disposal practices included disposal of uncontainerized chemical wastes and liquids in drums without added sorbents. The pit also was used as an evaporative pit. Pit A was filled with waste to within approximately three feet of the surface between 1964 and 1978, and then was covered with crushed, consolidated tuff.

The three surface impoundments (impoundments B, C, and D) are located northwest of pit A. Impoundment B was excavated in 1978 and is 60 ft long x 18 ft wide x 10 ft deep. It had a capacity of 7,560 ft^3 and operated from January 1979 to June 1985 to evaporate treated salt solutions and electroplating wastes. Impoundment C was closed in 1978. This impoundment, which is 35 ft long x 12 ft wide x 10 ft deep, was used for the same disposal purposes as impoundment B. Impoundment C had a capacity of 2,940 ft^3. Impoundment D is approximately 75 ft long x 18 ft wide x 10 ft deep and had a capacity of 9,450 ft^3. It was used to treat small quantities of lithium hydride by reaction with water. This practice began in 1972 and was discontinued in 1984. Impoundment D later was used as secondary containment for used oil storage tanks (see SWMU 54-021). The capacities of the impoundments were calculated assuming they were filled to within three feet of the surface. All three impoundments are covered with crushed tuff followed by asphalt.

The 34 disposal shafts at MDA L were drilled directly into the subsurface tuff. Shafts 1 through 28 are located south of pit A. Shafts 29 through 34 are located northwest of impoundments B, C and D. Three feet of crushed tuff were placed in the bottom of each shaft to fill cracks and joints. The shafts range from 15 ft to 65 ft deep and vary in diameter from 3 ft to 8 ft. Groups of shafts were constructed as needed. When in use, the shafts were covered with a steel cap that could be opened or removed, depending on design, to allow placement of waste. The operational dates of the shafts vary, but collectively the shafts were operated from February 1975 to December 1985. The shafts were used to dispose of containerized and bulk liquid chemical wastes. Before 1982, containerized liquids were disposed of without adding absorbents to the containers. Space around the drums was filled with crushed tuff and a 6-in. layer of crushed tuff was placed between each layer of drums. After 1981, uncontainerized waste was no longer disposed of in the shafts. From 1982 to 1985, wastes were accumulated on the site and packaged in drums until a sufficient quantity had accumulated to put the drums in a shaft. When filled, the shafts were covered with a concrete plug, approximately 3 ft thick.

Early disposal practices at MDA L resulted in a subsurface volatile organic vapor plume that extends beneath the facility and beyond its boundary. Several previous investigations have taken place at MDA L. Since 1982, channel sediments have been collected from permanent stations in the main drainages surrounding TA-54 to monitor the potential transport of radionuclides by stormwater run-off. In 1985, NMED issued a compliance order to LANL that required pore-gas characterization at MDAs G and L. Nine boreholes were drilled between 1985 and 1988 to monitor the subsurface VOC plume. Analytical data from the pore-gas monitoring shows that 1,1,1-trichloroethane is the primary plume constituent; it is present to at least 200 ft below the mesa surface; and concentrations vary across the plume. In 1986, additional boreholes were drilled to measure air permeability in the tuff. The data were used to evaluate the nature and extent and fate and transport of subsurface contamination at MDA L.

The ER Project conducted RFI fieldwork at MDA L from 1993 to 2001 to determine if releases had occurred and to characterize the nature and extent of the releases.

The RFI report for channel sediment pathways from MDAs G, H, J, and L describes the Phase I RFI of drainage channels associated with those MDAs. This RFI was part of the Phase I characterization of TA-54. Complete characterization of the MDAs includes analysis of samples from surface water and sediment, air, and subsurface vapor. This investigation focused on the MDAs collectively rather than individual disposal cells, shafts, or pits. The objective of this RFI was to determine if chemicals were migrating from the MDAs through the drainage channels by way of surface sediment transport and, if so, to determine if concentrations likely would adversely impact human health or the environment. Seventeen drainage channels were selected for sediment sampling based on their potential for having collected sediment run-off from the four MDAs. Fourteen drainage channels originate near MDA G, and the other three MDAs each have only one significant drainage channel. Sample locations were selected within depositional areas as determined by an on-site geomorphic analysis of each channel. Samples were screened for alpha, beta, and gamma radiation. Samples with gross gamma levels greater than three standard deviations above the mean value of a set of background sediment samples were sent for off-site laboratory analysis of TAL metals, PCBs, pesticides, cyanides, and radionuclides. Analytical results first were compared to background sediment concentrations from TA-39 and sediment concentrations from TA-54 drainage channels that had no history of receiving contaminated run-off. Chemicals with concentrations greater than background and chemicals with no background levels then were compared to SALs. All chemicals detected in MDA-related drainages were below their respective SALs. An ecological assessment of each MDA-related drainage consisted of an evaluation of the landscape condition for potential receptor access. Each MDA-related drainage was determined not to be an ecological concern because there was little receptor access. The channel sediment pathway RFI report stated that the ecological risk assessment process would be undertaken for the area when regulators approved the ecological exposure unit approach and recommended NFA for the drainage channels from MDAs G, H, J, and L.

An RFI report for MDAs G, H, and L was issued in 2000 to: (1) document the fieldwork and evaluate the potential human health and ecological risks posed by known and projected releases and exposures; (2) recommend (as necessary) additional investigation at TA-54 to reduce uncertainties associated with potential human health and ecological impacts; and (3) evaluate the need for near- and/or long-term corrective measures to reduce present-day and/or potential future risk. The RFI focused on identifying COPCs and developing a conceptual model for their fate and transport. In identifying COPCs, data of sufficient quality were compared with applicable thresholds (i.e., BVs) for inorganic chemicals, BVs and/or FVs for radionuclides, and instrument DLs for organic chemicals. Where data were not clearly less than the applicable threshold, analytes were retained as COPCs. Information used to develop the conceptual model for MDA L includes both non-ER and ER Project RFI data. RFI fieldwork at MDA L included the collection and analysis of 4 drainage sediment samples, 172 core samples from 16 boreholes, 268 VOC surface flux samples, 239 tritium surface flux samples, and 16 ambient air samples. The sediment samples were analyzed for inorganic chemicals, cyanide, PCBs/pesticides, radionuclides, and tritium. The ambient air samples were analyzed for VOCs. The core samples were analyzed for VOCs, SVOCs, inorganic chemicals, PCBs/pesticides, cyanide, and radionuclides. The RFI data were supplemented by environmental surveillance surface water data, VOC emissions data from passive extraction tests, and quarterly VOC pore-gas monitoring samples. Analytical results showed the presence of tritium at elevated levels in the ambient air flux samples and the subsurface tuff samples and organic chemicals in the subsurface and ambient air samples, which indicated a subsurface release. The primary VOCs identified are 1,1,1-trichloroethane and trichloroethene. Barium, copper, chromium, nickel, uranium, and zinc were detected at concentrations greater than BVs in subsurface tuff samples. The pesticide methoxychlor is present at concentrations below SAL in site sediments.

Evaluation of site data indicates that the known sources of environmental contamination at MDA L are vapor-phase tritium and VOC releases from the subsurface units and releases of metals dissolved in liquid solvents into the tuff below the subsurface units. Environmental transport pathways supported by data analysis are resuspension and dispersion in air and sediment transport in surface water for surface soil and sediment contaminated with methoxychlor (source unknown); diffusion in pore gas and dispersion in air for vapor-phase tritium and VOCs; and transport of dissolved metals, followed by sorption onto minerals and solid phases in tuff.

Present-day risks posed by MDA L to human and ecological receptors were characterized using a human health risk assessment and an ecological screening assessment. The risk assessment presented in the preliminary RFI report concluded that surface contamination at the site posed no unacceptable present-day risk to human health. No radionuclides or inorganic chemicals were detected in sediment samples collected at the site. Methoxychlor was detected but at concentrations similar to those found to pose no unacceptable present-day risk at MDA G. Results of ambient air risk assessment for VOCs indicated carcinogenic risks that were about equal to or below the lower end of EPA's acceptable risk range. Potential doses from tritium are below those shown to pose an acceptable risk in the MDA G risk assessment. The ecological screening assessment found that chemicals did not have the potential to cause adverse ecological impacts to receptors at MDA L. The results of the present-day risk assessment indicate that no action is necessary to address exposure of on-site workers to VOCs or tritium in air at MDA L. The risks, dose, and hazards associated with exposure to soil contaminants at MDA L were lower than those from exposure to VOCs and tritium in air and were below acceptable limits. The present-day ecological risk screening assessment at MDA L indicated no COPECs.

Quarterly pore-gas sampling of the vapor phase VOC plume at MDA L is ongoing; sampling results are reported in the ER quarterly reports. At the request of NMED, the RFI report for MDA L is being rewritten to incorporate additional recent information on the nature and extent of contamination.

References

RFI Report for Material Disposal Areas G, H, and L at Technical Area -54 LA-UR Number: 00-1140

Modification to Resource Conservation and Recovery Act Facility Investigation (RFI) Work Plan for Operable Unit (OU) 1148, Field Unit 5 LA-UR Number: No LA-UR

RFI Report for Channel Sediment Pathways from MDAs G, H, J and L, at TA-54 (located in former Operable Unit 1148) LA-UR Number: 96-0110

Proposed Action Plan Drilling Near Area [MDA] L, TA-54, OU 1148 LA-UR Number: No LA-UR

RFI Work Plan for Operable Unit 1148 LA-UR Number: 92-0855

CERTIFICATION

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

James L. Holt
Associate Director, Operations
Los Alamos National Laboratory
Operator

4/25/02
Date Signed

E. Dennis Martinez
Acting Director
U.S. Department of Energy
National Nuclear Security Administration
Office of Los Alamos Site Operations
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